WOLFCAMPIAN RUGOSE AND TABULATE CORALS (COELENTERATA: ANTHOZOA) FROM THE LOWER PERMIAN MCCLOUD LIMESTONE OF NORTHERN CALIFORNIA

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WOLFCAMPIAN RUGOSE AND TABULATE CORALS (COELENTERATA: ANTHOZOA) FROM THE LOWER PERMIAN MCCLOUD LIMESTONE OF NORTHERN CALIFORNIA[1]

Edward C. Wilson[2]

ABSTRACT. Six sections measured across the McCloud Limestone, Shasta County, northern California, are Lower Permian (Wolfcampian Series), represent a composite thickness of at least 5,500 feet (about 1,700 meters), and contain rich invertebrate faunas including at least 49 species of rugose and tabulate corals. Forty-two species in 17 genera of rugose corals are described, including 36 new species and 5 new genera. Seven species in five genera of tabulate corals are described, including four new species. The general generic composition is characteristic of the Durhaminid Coral Province known from rocks in the Ural Mountains, Novaya Zemlya, Spitzbergen, Arctic North America, and western North America as far south as southern California. Some genera appear to be endemic to western North America.

The corals did not form reefs but were randomly spaced on calcareous bioclastic substrates in shallow waters of the Cordilleran eugeosyncline near the Permian paleoequator in an area temporarily lacking much volcanic sedimentation.

INTRODUCTION

The primary purpose of this study is to determine the diversity and stratigraphic distribution of the stony corals of the McCloud Limestone, Shasta County, California. Six sections were measured and intensively sampled, and some additional collections were made at localities nearby the measured sections from the southernmost outcrop of the formation to about 20 miles (about 32 km) north along its general northeast trending strike (Fig. 1). In the remaining approximately 14 miles (about 22.5 km) of outcrop north of the measured sections, inspections were made on High Mountain and Bald Mountain, but the few corals collected were very poorly preserved. The section at Tombstone Mountain, which contains the highest Permian (Leonardian) rocks in the formation, is under study.

Fossils were selected for collecting in the following manners: (1) all corals, where feasible, were collected; (2) fusulinids were searched for near the exposed bases and tops of the sections, but within the sections they generally were collected only where abundant; (3) brachiopods were collected at localities where they appeared to be well preserved; (4) bryozoans were collected where abundant; (5) mollusks (bivalves, gastropods, cephalopods, rostroconchs) were collected where well preserved; (6) other conspicuous fossils were collected if well preserved, readily attainable, and of potential stratigraphic significance. The results are a relatively detailed sampling of the fossil corals of the southern part of the formation and a reconnaissance collection of other fossils. The specimens are deposited in the University of California Museum of Paleontology at Berkeley and the Natural History Museum of Los Angeles County, Invertebrate Paleontology Section.

Field work was pursued during the following intervals: 9–10 March, 19 March–4 April, 19–22 June, 7–11 September 1963; 19–20 April, 26–29 April 1964; 29 June 1967; 19–28 September 1968; 21–22 May 1970; 26 August–6 September 1973; 1–8 October 1976; 21–29 June 1979; 1–15 July 1981.

PREVIOUS WORK

Pioneer work on older rocks in Shasta County was begun by Trask (1853:15), who later found (Trask, 1855:50) a "Carboniferous" limestone there that cropped out from "the Pitt River in a northerly distance for about thirty or forty miles, forming a portion of the canyon of McCloud's Fork. . . ." He was followed by the California Geological Survey under J.D. Whitney, who collected from the limestone on 20 and 21 September 1862 (Brewer, 1930:323). From this collection, Meek (1864) described fusulinids, corals, brachiopods, and a gastropod, all reportedly Carboniferous. Whitney (1865:326) estimated that the formation was 1,000 feet thick and conformable to the formations above and below.

Fairbanks (1893:35) named the formation McCloud Limestone. In a differing opinion, Turner (1894:230) considered it to be part of the Calaveras Formation. The classical study of the Redding Quadrangle by Diller (1906) fixed the name McCloud Limestone and assigned the formation to the Pennsylvanian.

Hinds (1932:273) first placed the McCloud Limestone in the Permian. Using fusulinids, Wheeler (1933) confirmed this determination and later reported (Wheeler, 1935) fusulinids in "seven distinct faunal horizons" from the southern part of the formation. Thompson and Wheeler (1946) described fusulinids from

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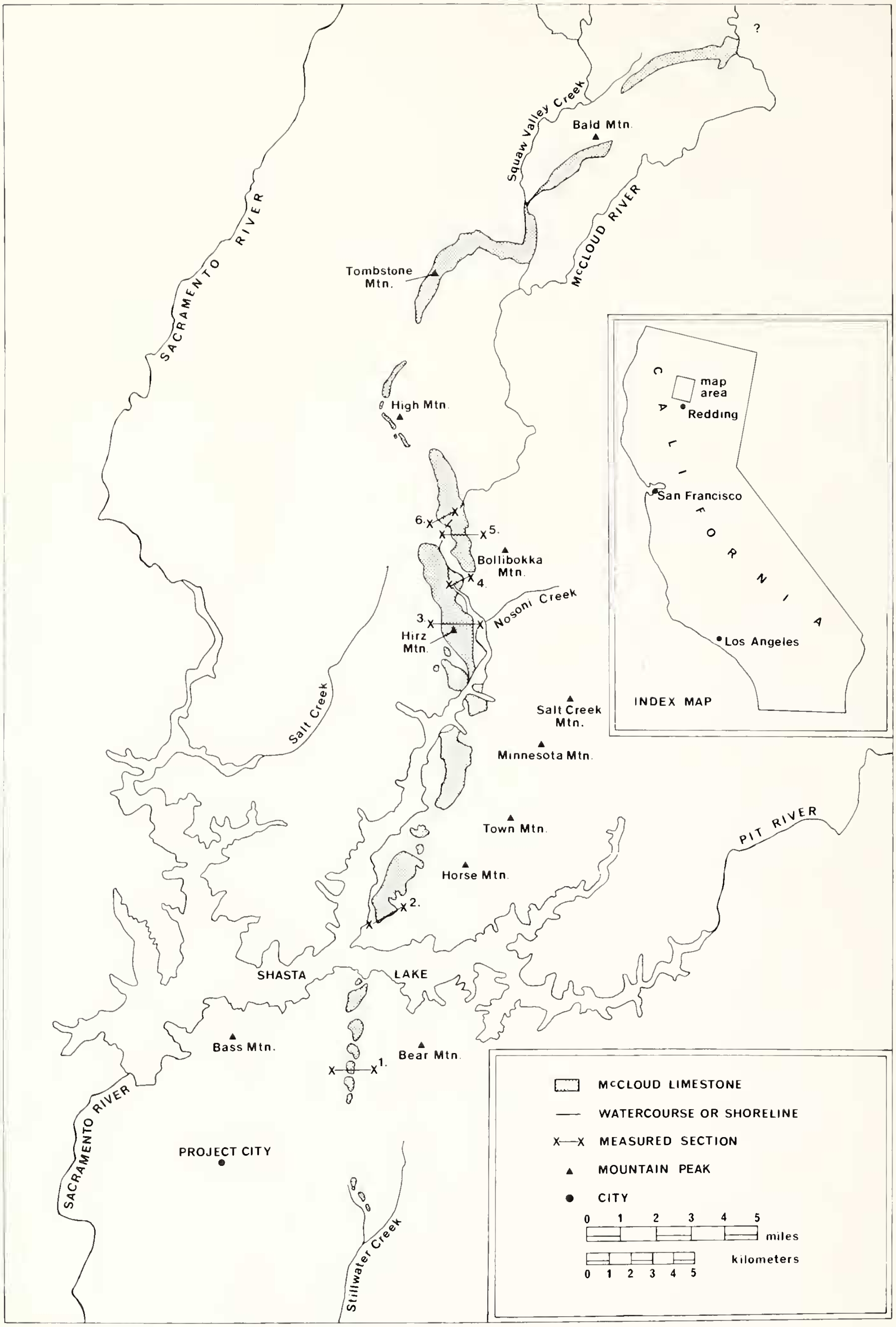

?
Squaw Valley Creek
Bald Mtn.
McCLOUD RIVER
SACRAMENTO RIVER
Tombstone Mtn.
High Mtn.
6.
5.
Bollibokka Mtn.
4.
Nosoni Creek
3.
Hirz Mtn.
Salt Creek
Salt Creek Mtn.
Minnesota Mtn.
Town Mtn.
PIT RIVER
Horse Mtn.
2.
SHASTA
LAKE
Bass Mtn.
Bear Mtn.
1.
SACRAMENTO RIVER
PROJECT CITY
Stillwater Creek
CALIFORNIA
map area
Redding
San Francisco
Los Angeles
INDEX MAP
McCLOUD LIMESTONE
WATERCOURSE OR SHORELINE
MEASURED SECTION
MOUNTAIN PEAK
CITY
0 1 2 3 4 5 miles
0 1 2 3 4 5 kilometers

the McCloud Limestone and Nosoni Formation as far north as Potter Ridge, concluding that the former formation was Wolfcampian and Leonardian and the latter was Guadalupian in age. Fusulinid paleontology and biostratigraphy were continued by Skinner and Wilde (1965), who showed that the formation represented an aggregate thickness in excess of 7,000 feet and zoned it for its entire outcrop length into eight complexly distributed zones, ranging from possible Upper Pennsylvanian into Lower Permian. Wilde (1971:364) later determined that the lowest zone is Permian.

Additional reports on fusulinids, corals, brachiopods, and mollusks from the formation were published by Hayasaka (1936:64), Langenheim and McCutcheon (1959), Watkins (1973, 1974, 1975), and Wilson (1967a and b, 1970, 1971, 1980:89).

Other information about the formation has continued to accumulate. Coogan (1960), Skinner and Wilde (1965), and Watkins (1973) pointed out that fossils at the top of the underlying Baird Formation at Bollibokka Mountain are Pennsylvanian or Permian, rather than Mississippian as at the type locality. Working farther south, Albers and Robertson (1961) reported that the McCloud Limestone is separated from the overlying Nosoni Formation by the largest fault in the area, the McCloud fault, along which quartz diorite is intruded. Lanphere, Irwin, and Hotz (1968) cited an age of 246 m.y. for the quartz diorite, indicating that the intrusion was a Permian event rather than a Jurassic one as previously believed. Evans (1977) reported on the economic geology of the southernmost McCloud Limestone.

Study of the petrography of the McCloud Limestone indicated to Demirmen and Harbaugh (1965) that it is formed largely of bioclastic sediments that originated in clear waters of a eugeosyncline, somehow protected from the volcanic sediments typical of the rest of the section.

In summary, although considerable work has been done on other aspects of the McCloud Limestone, thorough paleontological study has been limited to the fusulinids, although minor work has been done with the corals, brachiopods, and mollusks.

REGIONAL GEOLOGY

Rocks older than Silurian or younger than Triassic have not been positively identified among the eastward dipping, north-south trending, eugeosynclinal strata that rise south of Shasta Lake from beneath disconformably overlying Cretaceous and younger rocks and disappear northwards beneath the volcanic flows of the southern flanks of Mount Shasta. At least half of the entire rock column is composed of layered volcanic rocks.

Upper Paleozoic rocks represent parts of the Mississippian, Pennsylvanian, and Permian. They are known in ascending order as the Bragdon Formation, Baird Formation, McCloud Limestone, Nosoni Formation, and Dekkas Formation. Various divisions (members, groups) have been proposed based on lithology, and some zones and zonules have been erected based on fossils. The Bragdon Formation has Mississippian fossils. The Baird Formation contains Mississippian, Pennsylvanian, and possibly Permian fossils. The overlying three formations all are Permian.

The Pit stock, a Permian intrusive, follows the Baird-McCloud contact for many miles, locally intrudes faults in parts of these and other formations, and is followed by the McCloud River for much of its course south from Bollibokka Mountain. In the Potter Ridge area, an intrusion of mafic quartz diorite cuts the Pit stock in places.

STRUCTURE AND RELATIONSHIPS

The Paleozoic and Lower Mesozoic rocks of the Shasta Lake area form a slightly sigmoid north-south trending homocline, which dips eastward at angles varying from 45° to 60°. Coogan (1960:245) reported synclines and anticlines in the Bollibokka Mountain region. An additional small anticline is present in this area on the west bank of the McCloud River near the high-water line north of the McCloud River Bridge and south of Nawtawaket Creek. Albers and Robertson (1961, map) showed a north-south trending anticline in the block of McCloud Limestone north of Marble Creek. For its entire length, the McCloud Limestone is broken by transverse faults into discrete blocks. Numerous high-angle faults occur within some of these blocks.

There has been disagreement about the nature of the contact of the McCloud Limestone with the underlying and overlying formations at some localities. Although the scope of this report is primarily the coral paleontology of the formation, the following observations and conjectures may improve understanding of the structural and stratigraphic relationships.

1. On the eastern bank of the McCloud River directly north of the McCloud River bridge, the contact between the McCloud Limestone and the underlying Baird Formation consists of purple tuffaceous sediments, including conglomerate, and interbedded limestone, and seems to be gradational and sedimentary. The gradational rocks here were identified (Coogan, 1960:250; Skinner and Wilde, 1965:11) as the Baird Formation but are higher (Pennsylvanian or Permian) than at the Baird type locality (Mississippian).

2. A high-angle fault separates the McCloud Limestone and the Nosoni Formation along the east side of the ridge crest due east of the McCloud River bridge on Bollibokka Mountain and continues south for at least a mile. Diller (1906, map 3, top structure section) apparently recognized this fault, but some later workers considered the contact to be conformable.

3. About a mile north of the McCloud River bridge on the east bank of the river opposite Wittawaket Creek, Coogan (1960:249) described a depositional contact between the McCloud Limestone and the overlying Nosoni Formation. This is in a different fault block than the McCloud Bridge section of the present study. I inspected Coogan's contact and recognized that the lithology of the apparent top of the McCloud Limestone there

Figure 1. McCloud Limestone exposures in Shasta and Siskiyou Counties, northern California, showing locations of measured stratigraphic sections: (1) Bayha section, (2) Potter Ridge section, (3) Hirz Mountain section, (4) McCloud Point section, (5) McCloud Bridge East section, (6) McCloud Bridge West section.

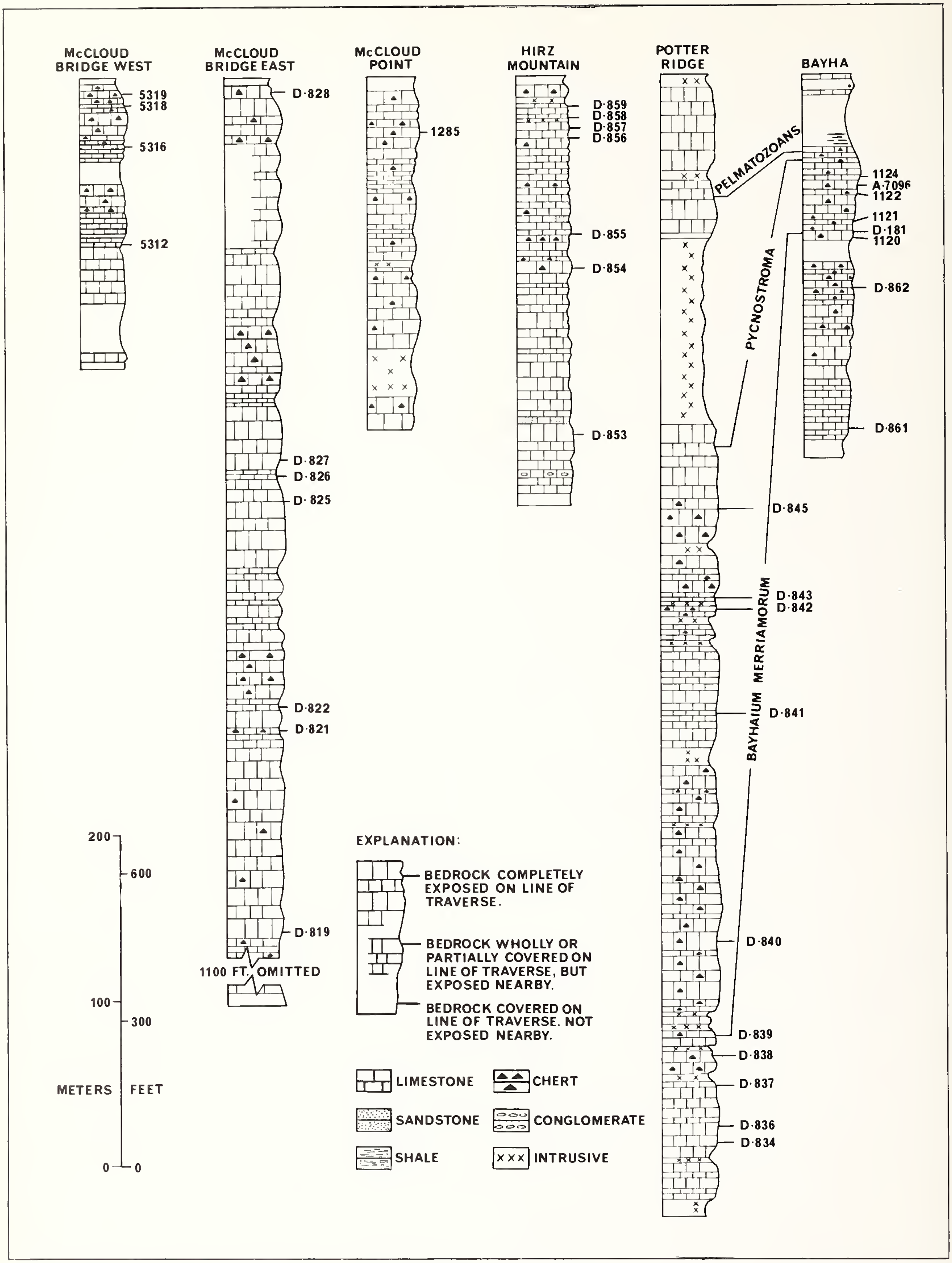


Figure 2. Columnar sections of the McCloud Limestone showing locations of coral collections.

differs from that at the top of the McCloud Bridge section, but I feel that the contact is worth further investigation.

4. At Hirz Mountain, an apparently gradational contact between the McCloud Limestone and the underlying Baird Formation is exposed along the road a few meters above the beginning of the steep upgrade that leads abruptly from the nearby horizontal access road to the summit of the mountain. The gradational contact has limestone beds that contain fusulinids. This contact also was recognized by Watkins (1973:1755), who erected the Hirz Mountain Limestone Member of the Baird Formation for nearby limestone lenses below the Baird-McCloud contact and considered it to be equivalent to fusulinid zone A, now known to be Wolfcampian. If this determination is correct, then the Pennsylvanian-Permian boundary here lies in the upper Baird Formation. It also implies that the fault block along the road should be in fusulinid zone A and therefore must be in a different fault block from the one measured at Hirz Mountain by Skinner and Wilde (1965), who assigned their section at Hirz Mountain wholly to fusulinid zone D. My Hirz Mountain section is not in the same fault block as the road and has zone D fusulinids.

5. Both the upper and lower contacts of the McCloud Limestone on the ridge between Marble and Potter Creeks are with an intrusion of mafic quartz diorite that probably rose along high-angle faults as emphasized by Albers and Robertson (1961:41).

6. In the Bayha section of the present study, both the upper and lower contacts of the McCloud Limestone are covered. A fine-grained shale was dug out here within 2 feet (0.6 meters) of the upper contact. No evidence of a conglomerate was seen. The lower contact, though covered by talus and deep soil, has small springs in places, suggesting the presence of an underlying fault.

7. A pebble conglomerate is present stratigraphically below definite Nosoni Formation rocks on the south side of the summit of the first knoll due south of the Gray Rocks. This hill is greatly faulted, and whether the conglomerate lies within the Nosoni Formation or at the base of the formation is not easily demonstrated because rocks below the conglomerate are not exposed. Fusulinids within the clasts of this conglomerate are referable to species in the McCloud Limestone.

8. Albers and Robertson (1961:57) recognized part of an extensive fault separating the McCloud Limestone and the Nosoni Formation between the Gray Rocks and the Curl Creek areas, named it the McCloud Fault, and described it as dipping west at a moderately steep angle, with left lateral and reverse movement, amount of displacement unknown. The full extent of this fault should be mapped to determine if it had a role in causing the present odd distribution of only older rocks in the southern part of the McCloud Limestone and only younger ones in the northern part.

STRATIGRAPHY, AGE, AND CORRELATION

Relationships of Sections in the McCloud Limestone

By 1935, the discrete fault blocks of the southernmost 9 or so miles (about 14.5 km) of the McCloud Limestone were known to correlate biostratigraphically. It was believed that the same correlation eventually would be obtained everywhere in the formation when its approximately 30-mile (about 48-km) length had been investigated. This expectation was shown to have been simplistic in 1965 when Skinner and Wilde published their monograph on the fusulinid faunas and biostratigraphy of the formation for its entire outcrop area. They stated (1965:12) that "the maximum thickness observed in any one place . . . is about 2,400 feet, but if the maximum observed thickness of the various [fusulinid] faunal zones were present in a single section the aggregate would be in excess of 7,000 feet." Correlation of the fault blocks proved to be complex. Of their 23 sections measured across the formation, 7 contain only a single zone, 12 have two zones, 3 have three zones, and 1 has four zones. No section has more than four of the eight zones.

The validity of this zonation has been substantiated by its recognition elsewhere in western North America.

Permian corals of western North America are not yet known thoroughly enough to be used more than locally with any assurance as index fossils. In general, however, the results obtained with the corals in the present study support the fusulinid zonation of Skinner and Wilde (1965) in the limited sense that the Potter Ridge and Bayha sections can be correlated using corals, as they can be with fusulinids, whereas the four more northerly sections, which could not be correlated by corals, were shown by Skinner and Wilde (1965) to be at various lower stratigraphic positions in the formation.

Six sections were measured in the McCloud Limestone with Jacob's staff or tape and Brunton pocket transit (Fig. 2). The tables of Mandlebaum and Sanford (1952) were used to compute the thickness of the taped sections. Ranges of coral genera in the formation were tabularized (Fig. 3), and occurrences of coral species were organized into a checklist (Fig. 4). Comments about the sections that relate to their stratigraphy, age, and correlation follow.

Bayha Section. The lower beds of my Bayha section contain very abundant specimens of the Wolfcampian index fusulinid *Pseudoschwagerina*. Four species of corals that occur in the Bayha section also were found in the Potter Ridge section. Seven species of corals found in the Bayha section were not recognized in the Potter Ridge section. Three species of corals described by Meek (1864) were not found by me in the Bayha section or elsewhere, although they reportedly were collected from that area. The large archaeogastropod *Omphalotrochus whitneyi* (Meek, 1864) occurs in the Bayha section, and the types were collected from there or nearby. It has a wide stratigraphic range in the McCloud Limestone and is the type species for the genus, now recognized as an index fossil for the Upper Paleozoic in North America, South America, Europe, and Asia. Near the top of the Bayha section are beds with abundant specimens of a biscuit-shaped blue-green alga. These are overlain with beds of particularly abundant and large pelmatozoan columnals that are not present elsewhere in the section. This sequence of algae and columnals also occurs near the top of the Potter Ridge section. The occurrences of coral species common to both sections and the sequential regularity of most of them and other fossils in each section confirm the correlation of the two sections with fusulinids by Skinner and Wilde (1965).

Potter Ridge Section. This section has been correlated with the Bayha section by Skinner and Wilde (1965) with fusulinids. I have described 15 species of corals from there, 4 of which also

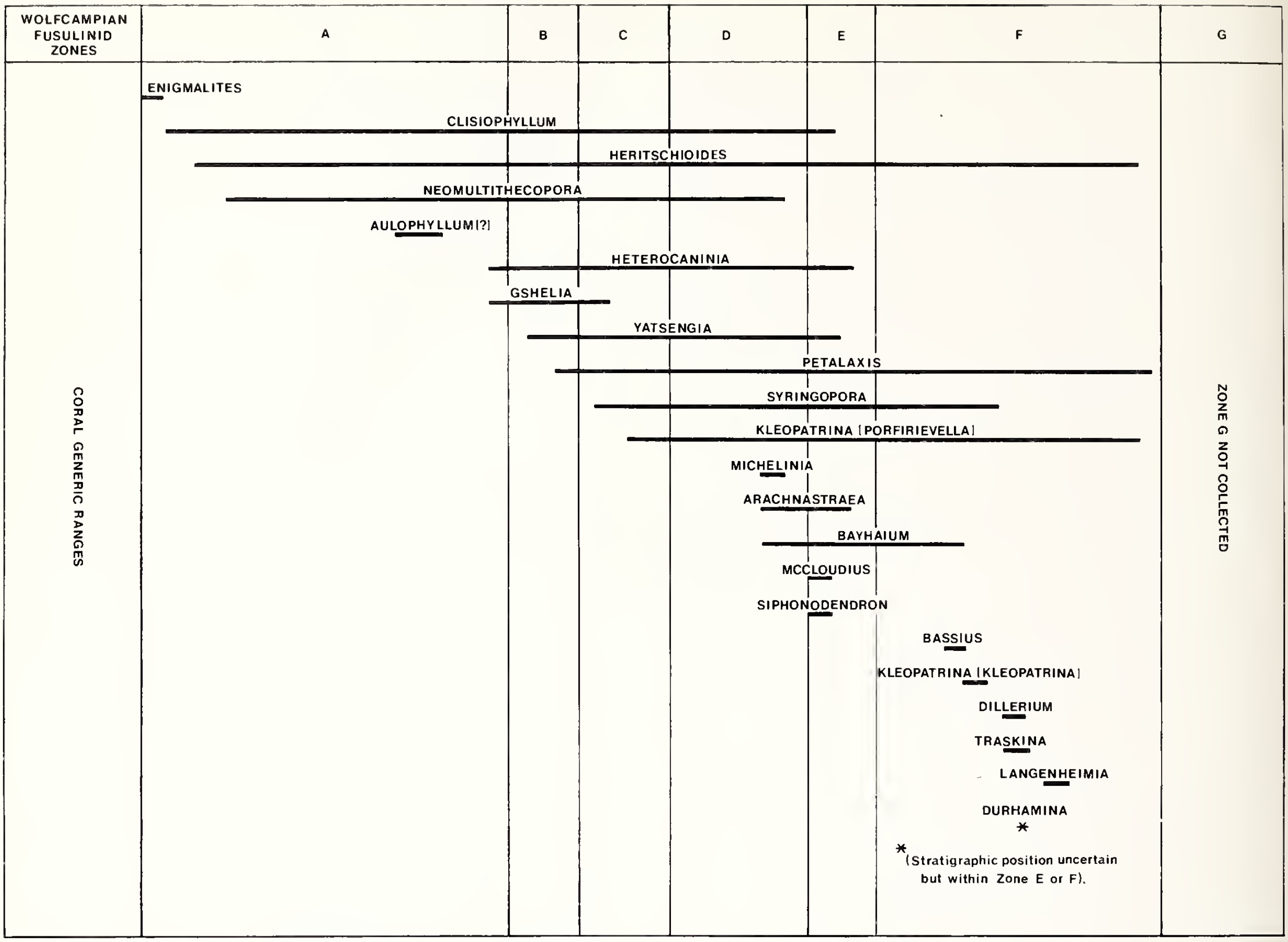


Figure 3. Stratigraphic ranges of coral genera in the McCloud Limestone Wolfcampian Series fusulinid zones of Skinner and Wilde (1965).

CHECKLIST OF MCCLOUD LIMESTONE WOLFCAMPIAN SERIES STONY CORALS	Section W. of McCloud River Bridge & nearby						Section E. of McCloud River Bridge & nearby														McCloud Pt. section	Hirz Mt. section & nearby					Potter Ridge section										Bayha section								Southern outcrop	Meek (1864) specimens
SPECIES LOCALITIES	5312	5316	5318	5319	A-7101	4457	D-819=4458	D-821=1132	D-822	D-825	D-826	D-827	D-828	D-800	D-801	D-803	D-804	D-805	D-831=1133	D-832	1285	D-853	D-855	D-857	D-858	D-852=1125	D-834	D-836=1114	D-837	D-838	D-839	D-840	D-841	D-842=1116	D-843	D-845	D-861=1119	D-862	1120	D-181	1121	1122	A-7096=1123	1124	B-4837	unknown
Solitary Rugosa																																														
Aulophyllum (?) sp.			X	X																																										
Clisiophyllum oweni n. sp.	X																																													
C. gabbi meek																																					X									X
cyathopsid (?)																																	X	X												
Gshelia americana n. sp.							X	X	X		X			X					X	X																										
Heterocaninia langenheimi n. sp.							X		X		X								X																											
Heterocaninia (?) sp.																																					X									
Fasciculate Rugosa																																														
Durhamina sublaeve (Meek)																																														X
Heritschioides wexoi n. sp.		X																																												
H. carneyi n. sp.						X																																								
H. hammani n. sp.													X																																	
H. skinneri n. sp.																	X																													
H. gavini n. sp.																					X																									
H. durhami n. sp.																										X																				
H. rowetti n. sp.																										X																				
H. wildei n. sp.																										X																				
H. smithi n. sp.																																X												X		
H. coogani n. sp.																																					X				X					
H. stevensi n. sp.																																						X								
H. merriami n. sp.																																							X							
H. (?) californiense Meek																																														X
Mccloudius fluvius n. gen., n. sp.																												X																		
Siphonodendron hongi n. sp.																																													X	
Yatsengia kenneyi n. sp.																		X																												
Y. fletcheri n. sp.																									X																					
Y. scheetzi n. sp.																											X	X		X																
Ceroid Rugosa																																														
Bassius mccloudensis n. gen., n. sp.																																								X						
Dillerium potterensis n. gen., n. sp.																																			X											
Kleopatrina (K.) raubae n. sp.																																		X								X				
Kleopatrina (Porfirievella) peggyae n. sp.												X																																		
K. (P.) zulloi n. sp.																							X																							
K. (P.) mckibbinae n. sp.																																		X									X	X		
K. (P.) whitneyi n. sp.																																														
Langenheimia klamathensis n. gen., n. sp.																																				X										
Petalaxis allisonae n. sp.																X																														
P. besti n. sp.																								X	X																					
P. kennedyi n. sp.																												X	X				X	X												
P. pecki n. sp.																																		X	X											
P. sutherlandi n. sp.																																				X										
Traskina shastensis n. gen., n. sp.																																			X											
Cerioid-asteroid Rugosa																																														
Arachnastraea fergusoni n. sp.																										X																				
A. fryi n. sp.																													X																	
Tabulata																																														
Bayhaium virginiae n. sp.																										X																				
B. merriamorum Langenheim & McCutcheon																														X	X									X						
Enigmalites roberti n. sp.					X																																									
Michelinia nelsoni n. sp.																										X																				
Neomultithecopora sandoi n. sp.						X		X	X						X	X			X	X					X	X																				
Syringopora multattenuata McChesney										X												X																								
S. mccutcheonae Wilson & Langenheim																																		X												

Figure 4. Checklist of coral species from the McCloud Limestone.

were found in the Bayha section and 11 of which were not. Other reasons for correlating the Potter Ridge and Bayha sections are discussed above under the latter section. The differences of the thicknesses of the two sections are likely due to faulting.

Hirz Mountain Section. Skinner and Wilde (1965) placed the Hirz Mountain section in part of a fusulinid zone that lies below the Bayha and the Potter Ridge sections. None of the 11 coral species described from the Hirz Mountain section occur in either the Bayha or Potter Ridge sections, and only 1 occurs in two of my sections measured north of Hirz Mountain. The archaeogastropod *Omphalotrochus* Meek, 1864, occurs at Hirz Mountain.

McCloud Point Section. A single species of coral is described from this section. It was not found in any of the other sections. The fusulinid *Pseudoschwagerina* is common in some beds of the McCloud Point section, but it is a different species from the one in the Bayha section. The archaeogastropod *Omphalotrochus* occurs in the McCloud Point section. Few other fossils were seen in this section, which is rather metamorphosed. Skinner and Wilde (1965) referred the section collected by me (east of the McCloud River) to parts of two fusulinid zones that do not correlate with my three southern sections. The lower part of the section measured by me correlates with the uppermost part of the section east of the McCloud Bridge according to Skinner and Wilde (1965), but the coral was found in the part of the section that is stratigraphically above my two northern sections.

Section East of McCloud Bridge. This section has parts of the lowest three fusulinid zones of Skinner and Wilde (1965). Nine species of corals are described from it and along strike in the great cliff in which it was measured. One coral species also occurs in the Hirz Mountain section and the section west of McCloud Bridge. The other eight species were found only in this section. The archaeogastropod *Omphalotrochus* is widespread in this section, and the type locality of the rostroconch mollusk *Conocardium langenheimi* is here. This fault block is highly fossiliferous and contains other kinds of invertebrates that are not well preserved in some of the other sections.

Section West of McCloud Bridge. Skinner and Wilde (1965) assigned this section to their lowest fusulinid zone and correlated it with the lower part of the section east of the McCloud Bridge. Of the six species of corals described from the section west of the McCloud Bridge, one was found in the section east of the McCloud Bridge and in the Hirz Mountain section. None of the other five species was found in the other sections. The archaeogastropod *Omphalotrochus* and the rostroconch mollusk *Conocardium langenheimi* also were found in the section west of the McCloud Bridge.

Occurrence and Comparison of Related Permian Coral Faunas

The corals described by Merriam (1942) from the Coyote Butte Limestone of Oregon are in part Permian and include species of *Heritschioides* that are not conspecific with species in the part of the McCloud Limestone of this study. According to Skinner and Wilde (1966), seven species of fusulinids from the Coyote Butte Limestone are Late Wolfcampian in age. Four of these species occur in the highest Wolfcampian zone of the McCloud Limestone, which crops out only north of the area studied by me, and the other three species were described as new. Skinner and Wilde (1966:11) also reported Cooper as having told them that none of his (Cooper, 1957) "latest Leonardian and probably . . . early Guadalupian age" brachiopods described from the Coyote Butte Limestone had fusulinids associated with them. If the Permian coral fauna of the Coyote Butte Limestone also occurs in the McCloud Limestone, it will be found higher in the section than the rocks reported on in the present study.

The type species of *Heritschioides* is from the Blind Creek Limestone of British Columbia (Smith, 1935), which may be Permian or older (Wilson, 1980:91). Although the type species does not occur in the McCloud Limestone, other species of the genus are common there, and the genus also was listed by Watkins (1973:1761) as occurring in the underlying Hirz Mountain Limestone Member of the Baird Formation.

Hoare (1964) described a small fauna of corals from Wolfcampian rocks near the Sunflower Reservoir of Elko County, Nevada, which had no genera in common with the McCloud Limestone corals found by me. Later, Hoare (1966) described a new species of *Bayhaium* from the same formation. This genus was erected for a species in the McCloud Limestone and was found by me to range through parts of three fusulinid zones there (D, E, and F). Wilde (1971:364) suggested that the fusulinids from the Sunflower area correlated with McCloud Limestone fusulinid zone A, at least in part.

Permian corals have been described from White Pine County, Nevada, by Easton (1960), McCutcheon and Wilson (1961), Wilson and Langenheim (1962), and Stevens (1967). They range from probable Wolfcampian to Leonardian. *Syringopora mccutcheonae* Wilson and Langenheim, 1962, occurs rather low in the section in White Pine County and is associated with a large fauna of colonial rugose corals. I found one corallum of *S. mccutcheonae* in the Potter Ridge section of the McCloud Limestone but no other species in the formation conspecific with any from White Pine County. The corals *Kleopatrina* and *Petalaxis*, however, are associated with *Syringopora mccutcheonae* in White Pine County, and their stratigraphic ranges are from below to above the occurrence of this species in the McCloud Limestone. However, the former two genera are represented by different species in the two areas. *Thysanophyllum* Nicholson and Thompson, 1876, is common in the White Pine County fauna but notably missing from the parts of the McCloud Limestone covered by the present paper. Perhaps the White Pine County faunas will be found higher in the more northern parts of the formation. *Durhamina* and *Heritschioides* are present in both White Pine County and in the McCloud Limestone. These genera are present in Leonardian rocks in White Pine County but not in probable Wolfcampian ones. It is curious that the single corallum of *Durhamina* from the McCloud Limestone should have been collected there by the California Geological Survey in 1862 and additional specimens not discovered in the field by me. There is a suggestion of a mixed collection here. The genus in White Pine County occurs in definite Leonardian rocks where the coralla are present in enormous numbers.

Kleopatrina ftatateeta (McCutcheon and Wilson, 1961) was described chiefly from specimens in White Pine County, Nevada, with some paratypes from the Wolfcampian of Clark County, Nevada. Minato and Kato (1965b:69) later erected a new species, *K. wilsoni*, for the figured paratype from Clark County. The genus, but neither of these species, occurs in the McCloud Limestone. McCutcheon (1961:1016) reported *Syringopora multattenuata* McChesney from the Wolfcampian in Clark County, Nevada. This species occurs in the McCloud Bridge section of the McCloud Limestone but has wide geographic and stratigraphic ranges in Pennsylvanian and Lower Permian rocks of the United States and perhaps even the Permian of Spitzbergen (Heritsch, 1939).

The report of *Lonsdaleia cordillerensis* Easton, 1960 (type species of *Durhamina*) in the Lower Permian of San Bernardino County, southern California, marks the southernmost reported existence of the Durhaminid Coral Province.

Thysanophyllum princeps Easton, 1960, was based, in part, on specimens from Millard County, Utah. This is the easternmost geographic record for the Durhaminid Coral Province in the Cordilleran geosyncline, well up on the shelf of the miogeosyncline. Stevens (1975:38) suggested that *Thysanophyllum* shows promise as an important index fossil for Permian rocks of the Cordilleran geosyncline.

Stevens (1977, fig. 6) synthesized studies of Permian corals and fusulinids in the western United States with tectonic research of the area and created a Permian paleogeographic reconstruction showing several north-trending marine depositional provinces beginning in the Idaho, Utah, and Arizona areas with an eastern outer shelf and progressing westward to California through an eastern shelf margin, an axial portion interior sea, an uplifted marginal belt, a back-arc basin, and a volcanic arc perhaps bordered to the west by a trench. On this model, the area of deposition of the McCloud Limestone is within the volcanic arc. Stevens (1977, fig. 7) compared this reconstruction to the present-day plate tectonic and depositional configurations in southeast Asia.

Permian coral faunas east and south of the Cordilleran geosynclinal rocks in North America belong to the Cyathaxonid Coral Province, which has a few widely ranging genera in common with the Durhaminid Coral Province (Rowett, 1975).

Rowett (1969) described species of *Durhamina, Heritschioides,* and *Syringopora* from the Wolfcampian or Leonardian of the east-central Alaska Range, Alaska. These genera also occur in the McCloud Limestone, although not the same species. Rowett (1969) also reported other genera from the same area that have not been reported from the McCloud Limestone. *Durhamina* and *Heritschioides* in Alaska are of particular importance in indicating the presence of the Durhaminid Coral Province there, particularly its North American part, which may be characterized by *Heritschioides.*

The generic (and some specific) compositions of Permian coral faunas in western North America in the eugeosynclinal and miogeosynclinal parts of the Cordilleran geosyncline are so similar that they suggest close geographic occurrences while living. Therefore, I do not believe that the eugeosynclinal coral faunas necessarily lived in a remote area not part of the North American continent that later was moved great distances by continental drift as suggested by Yancey (1975:763; 1976:241). Watkins 1979:36) considered the faunas (chiefly brachiopod and bivalve mollusk) of the Bragdon and Baird Formations, which underlie the McCloud Limestone, to be ". . . part of an Asiatic province." However, he reported (Watkins, 1973:1761) *Heritschioides* from the Baird Formation. This coral is restricted to western North America, as presently known, and reports of it elsewhere, including Asia, are doubtful or erroneous (Wilson, 1980). The Tethyan Coral Province of Asia is not present in North America.

From Alaska, the outcrops containing corals of the Durhaminid Coral Province turn eastward across Canadian North America to Spitzbergen and Novaya Zemlya and then south through the Ural Mountains of Russia.

PALEOECOLOGY

The fauna of the McCloud Limestone collected in the course of this study consists of algae, fusulinids, sponges, corals, bryozoans, brachiopods, several kinds of mollusks (including ammonoids, and nautiloids), echinoids, crinoids, and pelmatozoan columnals. Of these taxa, only the algae, sponges, bryozoans, and mollusks are known to occur in both fresh and marine waters. The fusulinids and ammonoids are extinct, but they have not been reported from rocks suspected of having been laid down in freshwater or brackish water. Living corals, brachiopods, nautiloids, and echinoderms are known only from marine environments and are stenohaline, except for a few brachiopods. I found no animals or plants that indicate that any of the McCloud Limestone was laid down under terrestrial, freshwater, brackish water, or hypersaline conditions. The entire fauna indicates a sea of normal salinity.

Fusulinids are stratigraphically widespread throughout the formation. Tasch (1957:396) thought that they probably lived in open-sea waters of 5- to 50-foot depths (1.5 to 15 meters). Thompson (1964:387) cited an offshore, open-water environment for them. The biscuit-shaped blue-green algae that are so abundant in some upper beds of both the Bayha and Potter Ridge sections are very much like certain Recent species that have been reported from intertidal and somewhat subtidal wave-affected environments (Ginsburg, 1960). In a study of paleoecology of Mississippian corals, Sando (1980b) used associations of corals and benthonic algae to determine maximum possible depth of occurrence of shallow-water corals. He arrived at a possible depth of 100 meters, which is the depth of the euphotic zone in clear, tropical seawater, but since the blue-green algae are confined to the upper 50 meters of the zone, he concluded that the probable depth for the shallow-water corals may have been mostly less than 50 meters. His conclusions seem applicable to the corals of the McCloud Limestone.

Wells (1957:773) considered Paleozoic colonial rugose corals to be indicative of well-oxygenated, gently circulating marine water with annual temperature minima of 16° to 21°C. Most paleogeographic maps show the Early Permian paleoequator crossing central California or northern Mexico, indicating that the McCloud Limestone was laid down in tropical seas, a theory strengthened by the relatively large number of coral taxa present in the formation.

I conclude that the McCloud Limestone was deposited in clear, shallow, warm marine water with full access to the open sea.

SYSTEMATIC MATERIALS AND METHODS

Morphological terminology has been taken from Moore, Hill, and Wells (1956) with a few additional terms added that are in widespread use. In my opinion, families in the orders Rugosa and Tabulata are so polyphyletic that they will not be useful until they have undergone stringent revision. Therefore, I have grouped the genera and species simply by order and, for the Rugosa, by the forms of the coralla (solitary, fasciculate, cerioid, cerioid-astreoid) and alphabetically within each form. The Tabulata are presented alphabetically.

Locality numbers with a letter prefix refer to the University of California Museum of Paleontology (UCMP) locality register. Locality numbers without a letter prefix refer to the Los Angeles County Museum of Natural History, Invertebrate Paleontology Section (LACMIP) locality register. Pertinent UCMP and LACMIP locality descriptions are placed in the section titled Localities. Existing specimens from the collection used by Meek (1864) now in the Museum of Comparative Zoology, Harvard University (MCZ) are listed as MCZ Meek Collection and, if the specimen bore a number, that number. Numbers preceded by USNM refer to United States National Museum, Washington, D.C., specimens. Types and other specimens are deposited in LACMIP, MCZ, and UCMP. References to fusulinid zones are those of Skinner and Wilde (1965), with age determinations amended by Wilde (1971:364).

SYSTEMATICS

Order Rugosa Milne Edwards and Haime, 1850

Solitary Rugosa

Genus *Aulophyllum* Milne Edwards and Haime, 1850

Aulophyllum (?) sp.

Figures 9a–b

External Description. Corallites solitary, large (diameters to 6 cm), cylindrical (?); calyx walls not preserved, but floor beyond ends of septa filled by axial boss 28 mm long, 13 mm wide, 14 mm high, conical, with 34 ridges (septal lamellae forming axial vortex spiraling counterclockwise to apex); corallite length, external walls not observed.

Transverse Section Description. Corallites circular to subcircular, maximum observed diameter 6 cm; major septa number 54 to 57 at 6 cm, 51 at 5.3 cm, all lanceolate and dilate but more so in cardinal quadrants, 20 to 23 mm long, most touching axial structure and continuous with septal lamellae; cardinal septum shortened, about 16 mm long, 1.5 mm wide where most dilate; cardinal fossula open; minor septa 6 to 11 mm long, not crossing dissepimentarium; dissepimentarium regular, 12 to 13 mm wide, except 7.5 mm wide beneath cardinal septum; dissepiments concentric, angulo-concentric, herringbone, pseudoherringbone, with about 12 to 15 ranks, the axial one thickened into an inner wall; axial structure aulophylloid, 13 mm wide, 20 mm long, filling entire space beyond ends of septa, composed of irregularly twisted septal lamellae, many connected to ends of septa, interspaced with numerous axial tabellae, forming complex mass, but axial vortex not as apparent as in external view of axial boss; corallite wall about 0.1 mm wide.

Longitudinal Section Description. Tabellae of 2 zones, axial and periaxial; axial tabellae of 5 to 10 ranks, steeply dipping from center down (outermost ones may recurve), generally very elongate, a few cystose; periaxial tabellae of 1 to 3 ranks, generally rather straight (few are cystose), sloping down and out gently from axial tabellae; dissepimentarium of 10 to 18 ranks of small, steeply dipping, cystose dissepiments.

Documentation. LACMIP hypotypes 6342–6343. Two thin sections and 11 polished sections from two coralla from LACMIP localities 5318 (hypotype 6342) and 5319 (hypotype 6343) were studied.

Discussion. The two specimens upon which this description is based are fragmentary. The ephebic stages can be reconstructed, but the apices of the coralla are missing so the neanic stages are unknown. *Aulophyllum* and *Auloclisia* Lewis, 1927, both are aulophylloid in the ephebic stages. The former is aulophylloid throughout, but the latter goes through early dibunophylloid and clisiophylloid stages. Therefore, I have questioned the generic assignment. Neither specimen is adequate for erection of a new species, and additional material may be available at the locality, which should be easy to relocate since it is at the summit of a prominent hill.

Aulophyllum apparently has not been reported from the Upper Paleozoic of North America. *Auloclisia deltense* Rowett, 1969, from the Permian of Alaska, is the only species of that genus recognized in North America to date. It is much smaller and has many fewer septa than *Aulophyllum* (?) sp.

Genus *Clisiophyllum* Dana, 1846

Clisiophyllum gabbi Meek, 1864

Figures 5:1, 1a; 6a–f; 7a–h; 8a–d

Clisiophyllum gabbi Meek, 1864, p. 8, pl. 1, figs. 1, 1a, 1b.

External Description. Corallites solitary, trochoid, complete specimen measuring 8.5 cm in length (outside curve) with 3.2-centimeter-diameter calyx, maximum observed corallite diameter 5.7 cm; wall rugose externally with faint growth lines; calyx about 2 cm deep with steeply sloping inner walls and very prominent central axial boss about 1 cm high.

Transverse Section Description, Lectotype. Corallite diameter 23 mm; septa of 2 orders; major septa 38, somewhat lanceolate in cardinal quadrants (not equally so in each cardinal quadrant), thinner in counter quadrants, 6 to 7 mm long, except cardinal septum 4.5 mm long, about half in contact with axial structure; minor septa very short (at this stage), about 1 mm long, crossing narrow dissepimentarium but not entering tabularium; axial structure clisiophylloid, large, filling most of tabularium, with slightly thickened sinuous medial plate and about 11 somewhat sinuous septal lamellae joined together by axial and periaxial tabellae; dissepimentarium narrow, of 1 to 2 ranks of herringbone, pseudoherringbone, or concentric dissepiments; wall thin, about 0.3 mm wide.

Longitudinal Section Description, Lectotype. Corallite diameter 20 mm; tabellae of 2 zones, axial and periaxial; axial tabellae of about 6 ranks, steeply dipping, cystose to elongate, sloping inwards and upwards to medial plate; periaxial tabellae of 2 to 5 ranks, sigmoid to cystose, gently sloping inwards and upwards to axial tabellae; dissepimentarium of 1 to 2 ranks of small, steeply dipping, cystose dissepiments.

Documentation. A lectotype (Figs. 6b–c) is here designated from the MCZ Meek collection block no. 19, which bears five coralla. It was not figured by Meek (1864). His three figured specimens of this species are not very suitable for preparation of thin sections, and therefore the International Code of Zoological Nomenclature (ICZN) Recommendation 74B (a lectotype should be a figured syntype) was not followed. Two thin sections were made of the lectotype. MCZ Meek collection block no. 23 (about six coralla, including two polished longitudinal sections apparently prepared by Meek), MCZ Meek collection block no. 24 (a laterally crushed fragmentary corallum), two MCZ Meek collection unnumbered coralla (both fragmentary and poorly preserved, including the large specimen figured by Meek [1864, pl. 1, fig. 1—apical part now missing]), and the remaining four specimens on MCZ Meek collection block no. 19 here are designated paralectotypes. All the MCZ Meek collection blocks with specimens of this species have labels glued to them reading "*Clisiophyllum Gabbi*, Meek."

In addition to the above specimens, 12 coralla from UCMP locality D-861 were studied from nine thin sections and numerous polished sections, and more than 100 coralla from LACMIP locality 1119 (UCMP loc. D-861) were examined. Coralla from which thin sections were prepared are designated UCMP hypotypes 37171–37175 and LACMIP hypotype 6344.

Discussion. This species is common in the lower 50 feet of the McCloud Limestone at the Bayha section where it occurs in a coquina of the zone E fusulinid *Pseudoschwagerina robusta*.

The above description is based on thin sections of the lectotype. Measurements and counts of major septa from thin sections showing the ontogeny of one corallum from UCMP loc. D-861 are: 6-mm corallite diameter, 21 septa; 10-mm corallite diameter, 27 septa; 18-mm corallite diameter, 33 septa; 23-mm corallite diameter, 36 septa. Other coralla from the same locality show that the number of septa increases to 38 at 24-mm corallum diameter and 49 at 33-mm corallum diameter. In the latter large specimen, the dissepimentarium has about nine ranks of dissepiments, but the minor septa penetrate only the outer two or three ranks. The largest specimen examined is 57 mm in diameter and has 57 major septa.

There is considerable variation in this species in the dilation of septa in the cardinal quadrants and in the sinuosity of the axial plate. The lectotype has a readily discernible axial plate, whereas many other specimens have such a sinuous one that it cannot be distinguished in transverse section, although it is easily seen in longitudinal sections cut at right angles to the cardinal-counter plane. Septa of the lectotype are somewhat thinner than those of some other specimens.

The differences of *C. gabbi* and *C. oweni* n. sp. from lower in the McCloud Limestone are noted in the discussion for the latter species.

Clisiophyllum sp. A of Rowett (1969:57, pl. 7, figs. 1, 2), from the Lower Permian McCallum Creek sequence of the east-central Alaska Range, Alaska, is known from only two corallites, but these are very similar to *C. gabbi* and may be conspecific with it.

Clisiophyllum oweni n. sp.

Figures 9c–e

Diagnosis. A species of *Clisiophyllum* characterized by the combination of small corallites, complex symmetrical axial structures from which major septa are withdrawn, and minor septa of variable length but generally confined to the tabularium. It has smaller corallites, smaller and more symmetrical axial structures, and less numerous septa than *C. gabbi*. It has fewer and shorter septa and more symmetrical axial structures than *C.* sp. A of Rowett.

External Description. Corallites solitary, ceratoid or cylindrical; maximum length observed 6 cm (outside), diameter at calyx 1.7 cm; maximum diameter observed 2 cm; wall rugose, highly constricted in places; calyx about 1.5 cm deep, with steeply sloping or overhanging walls and central axial boss of uncertain height.

Transverse Section Description. Corallite diameters 15 to 20 mm; septa of 2 orders; major septa 32 at 20-mm diameter (holotype), slightly dilate in cardinal quadrants, thinner in counter quadrants, 3.5 to 5.2 mm long, except cardinal septum about 4 mm long, septa withdrawn from axial structure; minor septa short, some crossing dissepimentarium, very few entering tabularium as spines; axial structure clisiophylloid, 3 by 4 mm to 4.5 by 5.5 mm, with slightly thickened medial plate and 12 to 22 septal lamellae symmetrically joined by axial and periaxial tabellae; dissepimentarium narrow, of 1 to 4 ranks of herringbone, pseudoherringbone, concentric, or angulo-concentric dissepiments; wall thin, about 0.1 mm wide.

Longitudinal Section Description. Tabellae of 2 zones, axial and periaxial; axial taballae of 3 to 7 ranks, steeply dipping, elongate to cystose, sloping inwards and upwards to medial plate; periaxial tabellae of 3 to 5 ranks, straight to cystose, gently sloping inwards and upwards to axial tabellae; dissepimentarium of 1 to 4 ranks of steeply dipping, mixed size dissepiments.

Documentation. LACMIP holotype 6345, LACMIP paratype 6346. Three thin sections and five polished sections from two coralla from LACMIP locality 5312 were studied.

Discussion. *Clisiophyllum gabbi*, from much higher in the McCloud Limestone, has larger corallites (to 35 mm), somewhat more septa (33 to 38 septa at 18 to 23 mm, 48 at 35 mm) that are more dilate in the cardinal quadrants, and an axial structure that is larger and less symmetrical. *C.* sp. A of Rowett, 1969, from the Lower Permian McCallum Creek sequence, Alaska Range, Alaska, is comparable in size to *C. oweni*, but the former has

Figure 5. McCloud Limestone rugose corals from Meek (1864).

Parts 1 and 1a. *Clisiophyllum gabbi* Meek, 1864. **Part 1,** MCZ paralectotype, MCZ Meek collection unnumbered specimen. **Part 1a,** MCZ paralectotype on MCZ Meek collection block no. 23.

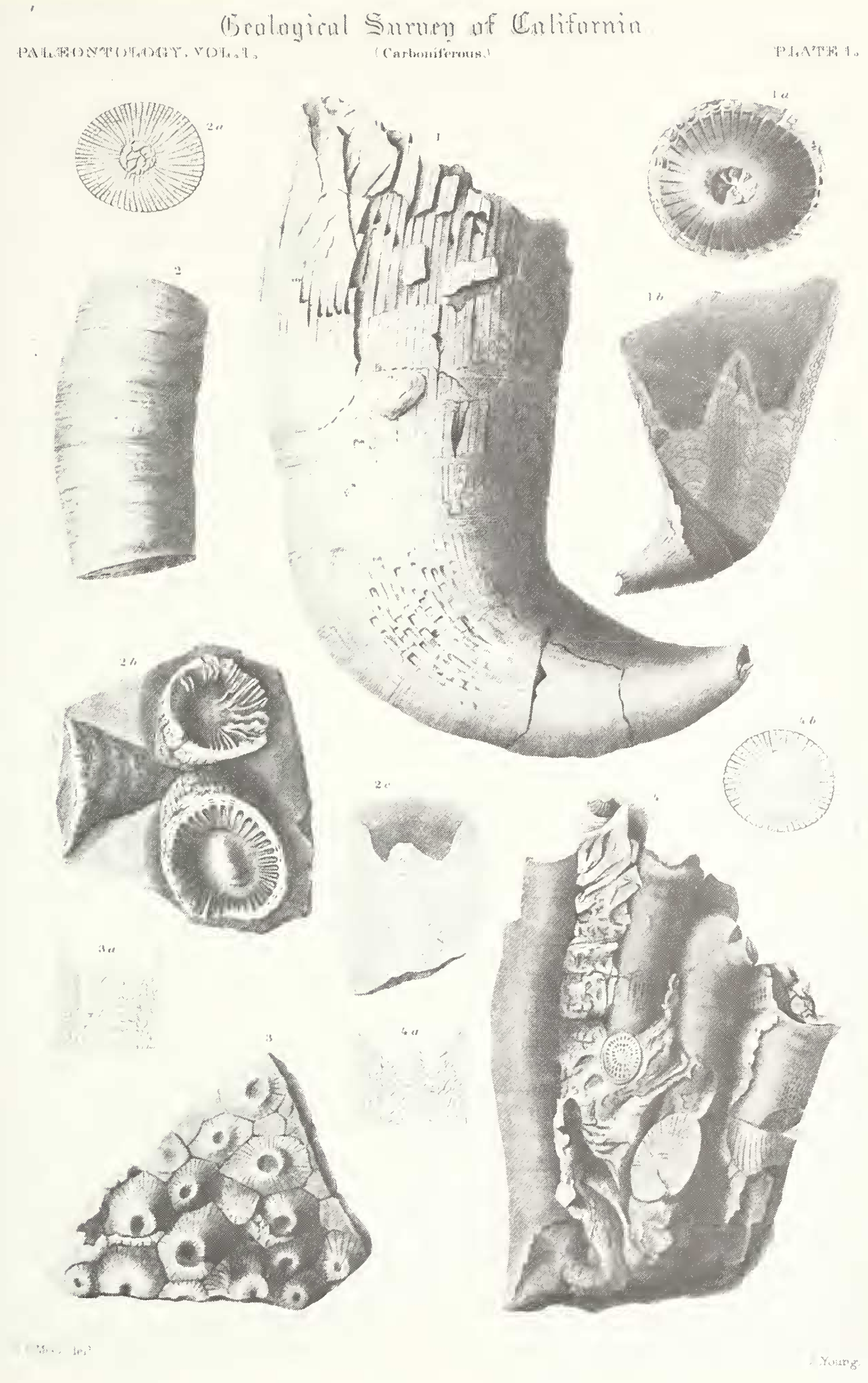
Parts 1b, 2, and 2a. Identification uncertain. **Part 1b,** no specimen now in the MCZ Meek collection exactly matches this figure. **Parts 2 and 2a,** this specimen is not now in the MCZ Meek collection.

Part 2b. *Heritschioides* (?) *californiense* (Meek, 1864), MCZ lectotype, on MCZ Meek collection block no. 13.

Part 2c. Identification uncertain; this specimen is not now in the MCZ Meek collection.

Parts 3 and 3a. *Kleopatrina (Porfirievella) whitneyi* n. sp., holotype, MCZ Meek collection corallum no. 15.

Parts 4, 4a, and 4b. *Durhamina sublaeve* (Meek, 1864), holotype, MCZ Meek collection corallum no. 17.



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PALÆONTOLOGY, VOL. 1. (Carboniferous.) PLATE 1.

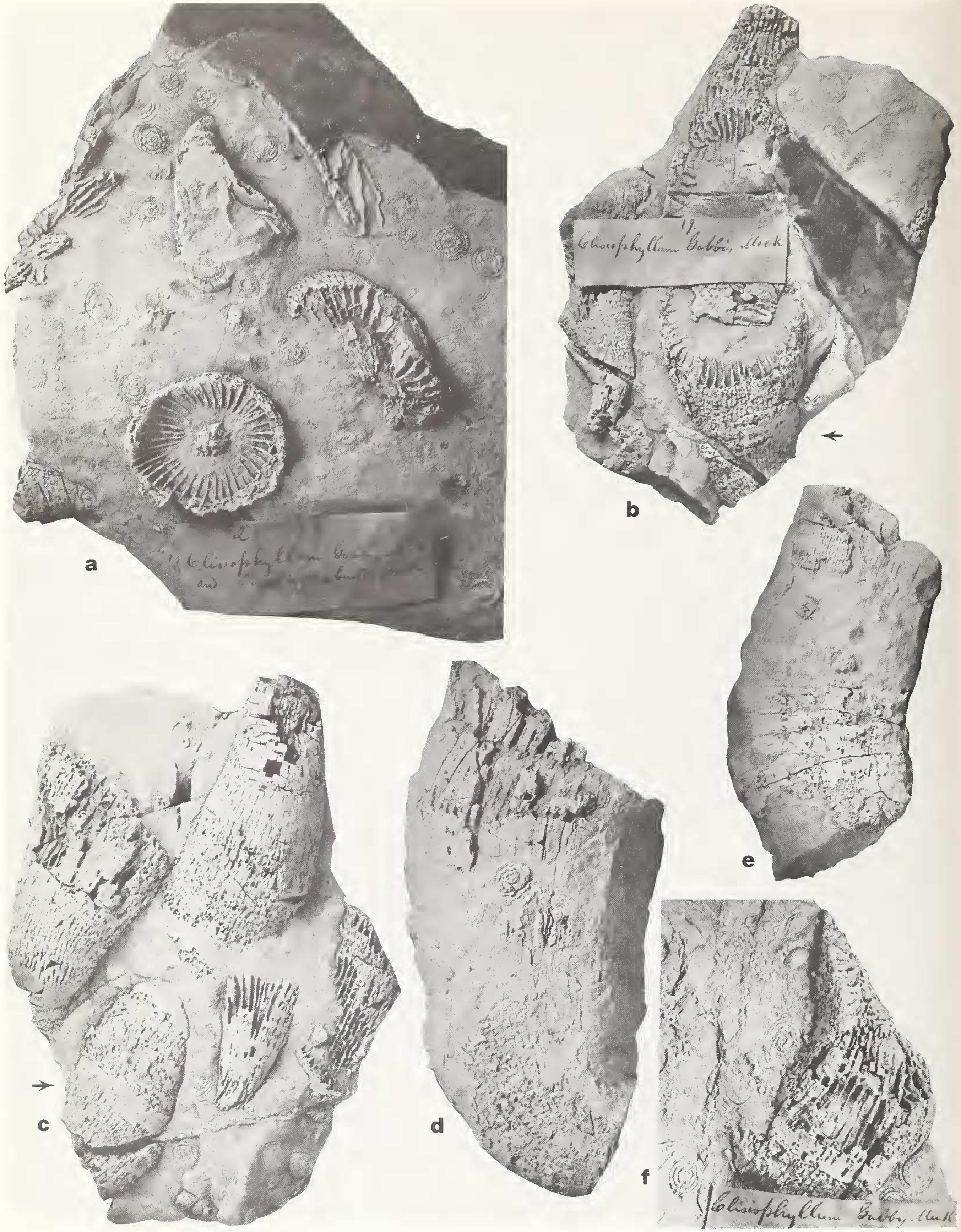


Figure 6. *Clisiophyllum gabbi* Meek, 1864. Fusulinids in Parts a–d and f are *Pseudoschwagerina robusta* (Meek, 1864). **Part a,** MCZ paralectotypes, MCZ Meek collection block no. 23, complete calyx figured by Meek (1864, pl. 1, fig. 1a), x1. **Part b,** MCZ lectotype (lower right) and paralectotypes, MCZ Meek collection block no. 19, x0.8. **Part c,** MCZ lectotype (lower left arrow) and paralectotypes, MCZ Meek collection block no. 19, obverse of Part b, x0.8. **Part d,** MCZ paralectotype, MCZ Meek collection unnumbered corallum, figured by Meek (1864, pl. 1, fig. 1), missing apical part presumed lost, x1. **Part e,** MCZ paralectotype, MCZ Meek collection no. 24, x0.5. **Part f,** MCZ paralectotype, MCZ Meek collection block no. 1, x1.

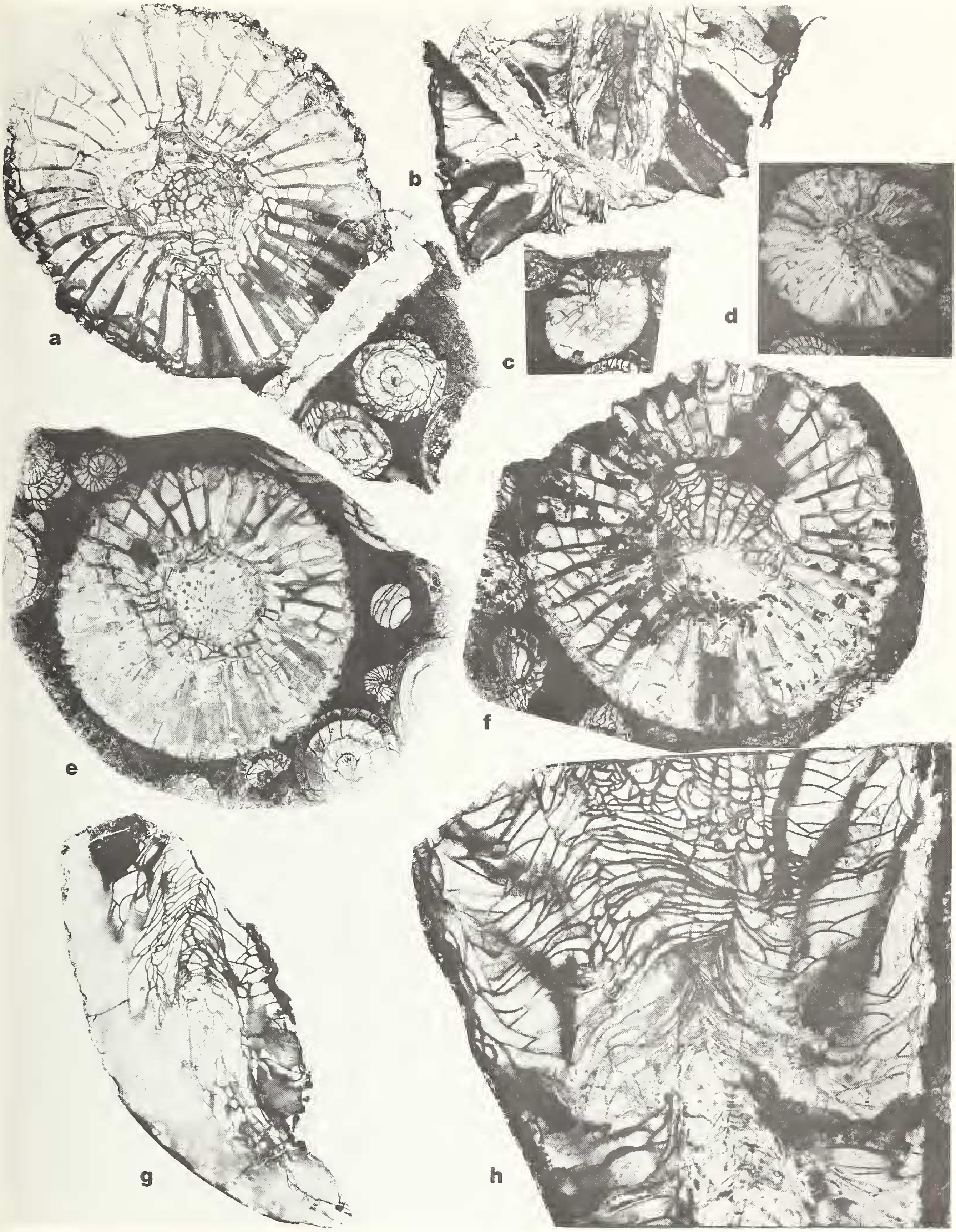


Figure 7. *Clisiophyllum gabbi* Meek, 1864. Fusulinids are *Pseudoschwagerina robusta* (Meek, 1864). All parts x3. **Parts a and b,** MCZ lectotype from MCZ Meek collection block no. 19, transverse and longitudinal sections. **Parts c through f,** UCMP hypotype 37171, serial transverse sections through one corallum. **Part g,** UCMP hypotype 37172, longitudinal section. **Part h,** LACMIP hypotype 6344, longitudinal section.

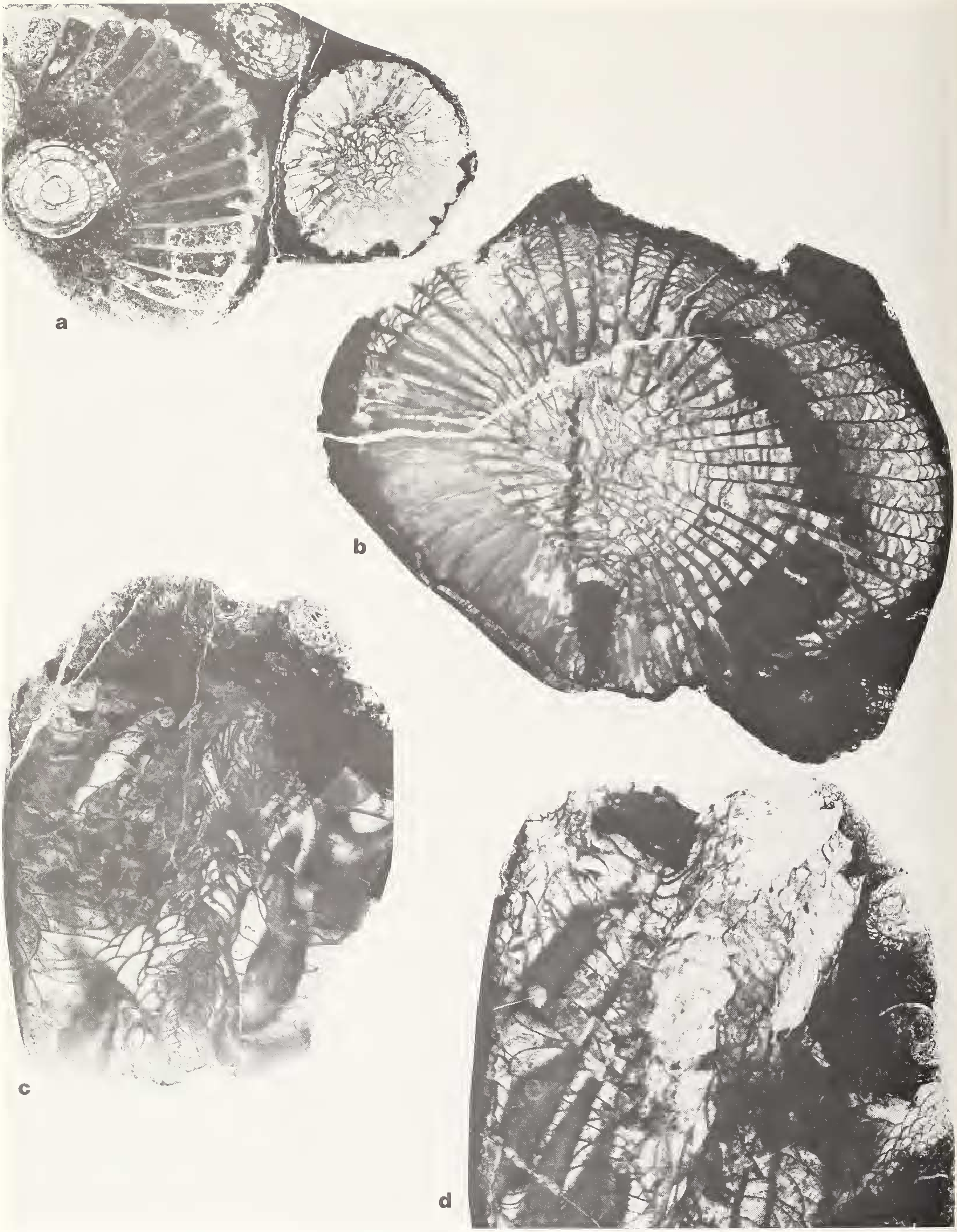


Figure 8. *Clisiophyllum gabbi* Meek, 1864. Fusulinids are *Pseudoschwagerina robusta* (Meek, 1864). All parts x3., **Parts a and b,** UCMP hypotype 37174, serial transverse sections through one corallum. **Part c,** UCMP hypotype 37173, longitudinal section. **Part d,** UCMP hypotype 37175, longitudinal section.

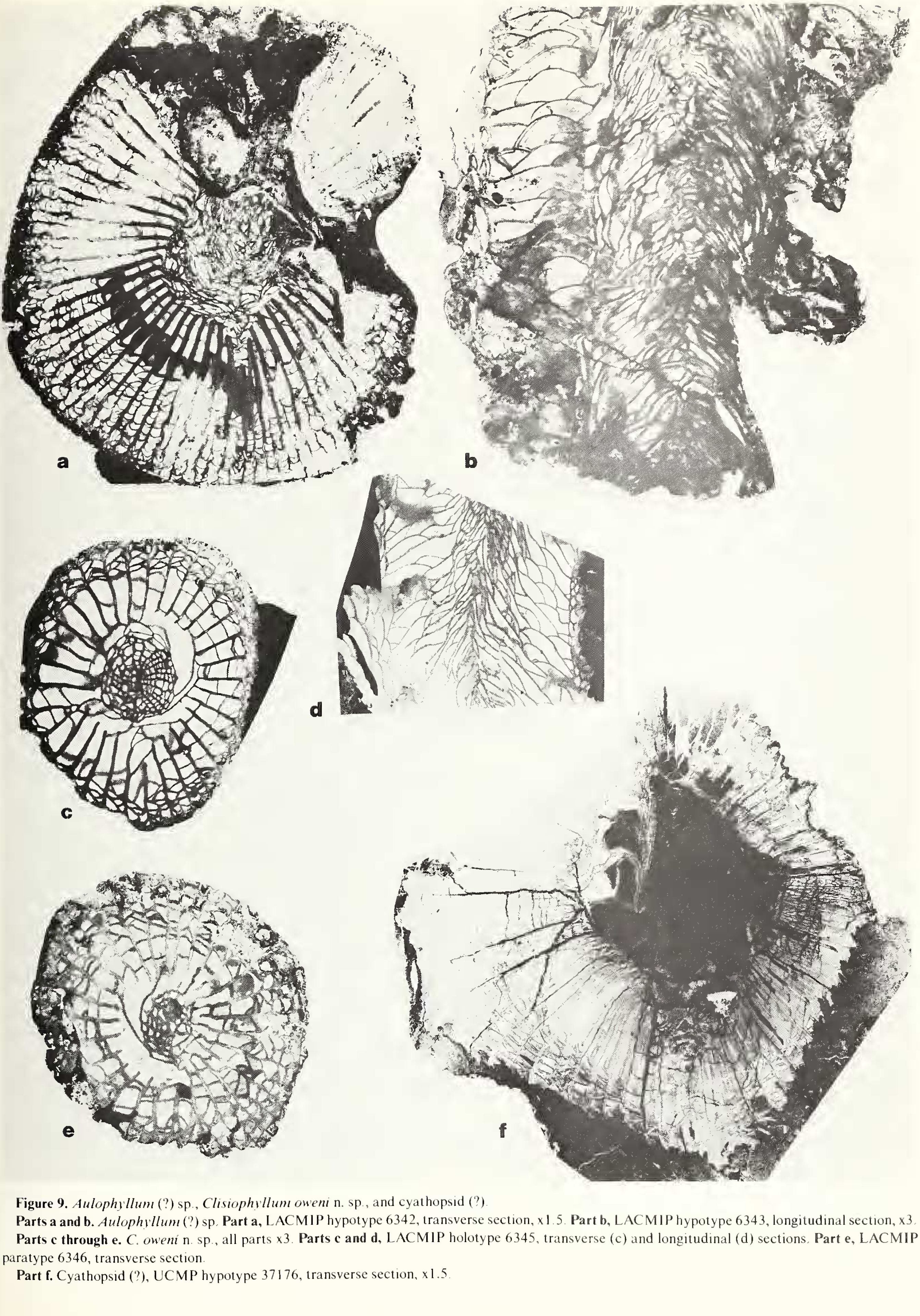


Figure 9. *Aulophyllum* (?) sp., *Clisiophyllum oweni* n. sp., and cyathopsid (?).

Parts a and b. *Aulophyllum* (?) sp. **Part a,** LACMIP hypotype 6342, transverse section, x1.5. **Part b,** LACMIP hypotype 6343, longitudinal section, x3.

Parts c through e. *C. oweni* n. sp., all parts x3. **Parts c and d,** LACMIP holotype 6345, transverse (c) and longitudinal (d) sections. **Part e,** LACMIP paratype 6346, transverse section.

Part f. Cyathopsid (?), UCMP hypotype 37176, transverse section, x1.5.

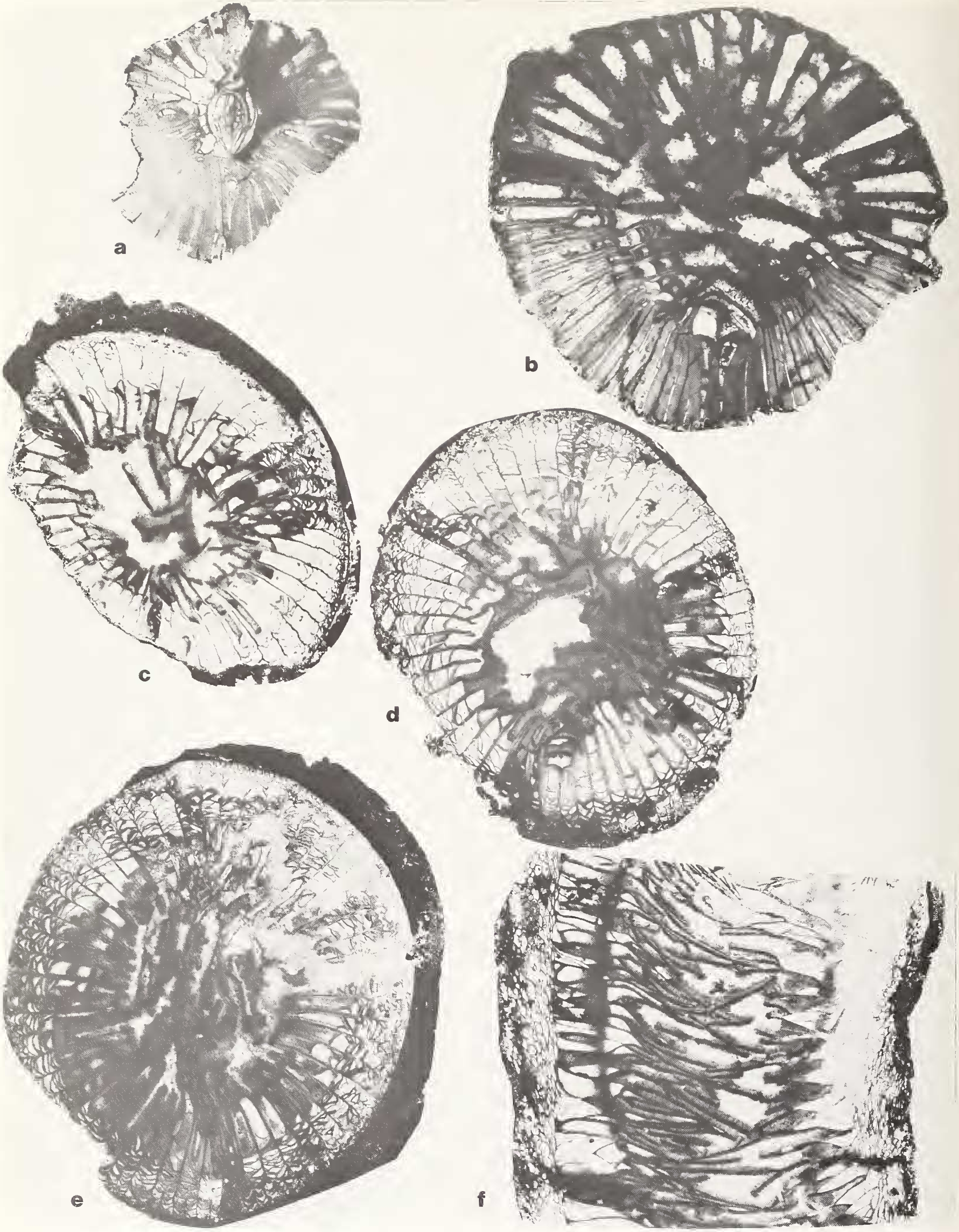


Figure 10. *Gshelia americana* n. sp., LACMIP holotype 6347. **Parts a and b,** serial transverse sections, x3. **Parts c through e,** serial transverse sections, x1.5. **Part f,** longitudinal section, x1.5.

more major septa (28 at 8 mm, 39 at 18 to 22 mm), longer minor septa, and a less symmetrical axial structure.

Etymology. The species is named for Mr. Phillip G. Owen.

Cyathopsid (?)

Figure 9f

Description. Corallites large, solitary, exterior unknown; adolescent stages unknown; adult corallite diameters 6 to 7 cm; septa of 2 orders, 76 to 90 each; major septa 14 to 21 mm long, thin in dissepimentarium, somewhat dilate in cardinal quadrants in tabularium, thin in counter quadrants, cardinal septum short, 10 to 16 mm long, and dilate; minor septa short, 3 to 6 mm long, thin, confined to periphery of dissepimentarium; dissepimentarium wide, 6 to 11 mm; dissepiments in 11 to 20 ranks, pseudo-herringbone between minor and major septa, herringbone or complete (many straight, some concentric) between major septa; narrow stereozone on axial row of dissepiments; corallite wall thin, generally not preserved.

Documentation. UCMP hypotypes 37176–37178. Three coralla from UCMP localities D-841 (hypotype 37178) and D-842 (hypotypes 37176–37177) were studied.

Discussion. The preservation of these specimens is poor due to partial crushing, apparent preburial abrasion of most of the external walls and adjacent dissepimentaria, and loss of structures due to styolite resorption. The corals are not uncommon but difficult to collect. It is important to record the existence of these large solitary corals because they are associated with both cerioid and fasciculate compound rugose corals at these localities.

The description is based upon transverse sections of ephebic stages only. It was not possible to make longitudinal sections of the coralla available. However inadequate the preservation, it seems obvious to me that these specimens are referable to the Cyathopsidae because of their resemblances to *Bothrophyllum* Trautschold, 1879, *Timania* Stuckenberg, 1875, and *Gshelia*. No North American Permian cyathopsid has been described with such a great number (90) of major septa, and therefore comparisons with the few other recorded species are unnecessary.

Genus *Gshelia* Stuckenberg, 1888

Gshelia americana n. sp.

Figures 10a–f; 11a–e; 12a–d

Diagnosis. A species of *Gshelia* characterized by the combination of very large corallites, numerous major septa, and minor septa confined to the dissepimentarium. It has larger corallites and shorter minor septa than *G. rouilleri.* It has shorter minor septa than *G.* (?) *lonsdalei.* It has longer major septa and shorter minor septa than *G. rouilleri* var. *breviseptata.* It has a more complex axial structure than *G.* (?) *nikitini.*

External Description. Corallites solitary, cylindrical beyond short apices with angles of 30–35°, straight, irregularly curved, or with abrupt 90° or smaller angle bends, large diameters to 8.1 cm, lengths to 47 cm (incomplete) and more (holotype length 31 cm); epitheca with closely spaced, fine growth lines and widely spaced annual (?) constrictions; calices deep, sides sloping steeply inwards and downwards, cardinal fossula prominent.

Transverse Section Description, Holotype. Corallite circular to subcircular, 5.4 cm maximum diameter; septa of 2 orders, 50 to 55 each at maturity, all extending to corallite wall; major septa thin in dissepimentarium, highly dilate in cardinal quadrants in tabularium in adolescent and early adult stages, slightly dilate elsewhere in tabularium, 14 to 19 mm long in adult stage, cardinal septum shortened, 10 to 12 mm long in adult stage; minor septa thin, short, confined to peripheral ⅓ of dissepimentarium in adult stage, not crossing dissepimentarium, not seen at diameters less than 30 mm; major septa at corallite diameters 27, 35, 47, and 50 mm number 48, 51, 55, and 52 (actual decrease), respectively; microstructure of dilate septa shows fibers at right angle to sinuous, dark, centerline; cardinal fossula open, with 3 to 5 tabulae arched around axial end in some sections; axial structure present only in adolescent stage, clisiophylloid at 20-mm corallite diameter with slightly dilate medial plate 2.5 mm long and 6 discontinuous septal lamellae united by 5 concentric tabellae (axial structure absent at corallite diameters 30 mm and greater, leaving open tabularium); dissepimentarium wide, width 3 to 9 mm in adult stages, not observed at corallite diameters less than 20 mm; dissepiments in 10 to 17 ranks in adult stage, regular peripherally, herringbone axially; stereozone on axial row of dissepiments in cardinal quadrants; corallite wall very thin, width 0.1 to 0.2 mm, silicified.

Transverse Section Description, Paratype Variation. Paratype 37183: major septa at corallite diameter 6 mm (smallest diameter sectioned in this species) number 20, all thin, withdrawn from center, without axial structure; major septa at corallite diameter 18 mm number 40, all dilate, with axial structure; major septa at corallite diameter 45 mm number 51, cardinals dilate, counters thin, axial structure absent.

Paratype 37184: major septa at corallite diameter 17 mm number 32, all dilate except 1 counter quadrant on apical side of section, all dilate on calicular side of section.

Paratype 6348: major septa at corallite diameter 37 mm number 49, cardinal quadrant septa dilate, counter quadrant septa thin, cardinal septum short, major septa at corallite diameter 60 mm number 64, cardinal quadrant septa slightly dilate, counter quadrant septa thin, cardinal septum short. This specimen shows middle to late adult stage transition by thinning cardinal quadrant septa.

Paratype 6355 (largest specimen): major septa at corallite diameters 78 mm and 81 mm (sections 95 mm apart) number 60 in each, cardinal septum short, 16 mm long, dilate, cardinal quadrant septa slightly dilate, those neighboring fossula more so, counter quadrant septa thin, major septa length 28 mm total, 9 to 13 mm in tabularium, not meeting; minor septa short, 4 to 6 mm long, not crossing dissepimentarium; dissepimentarium regular, wide, 13 to 19 mm width, dissepiments as in holotype; tabularium 41 mm wide, open in center; wall thin, silicified.

Longitudinal Section Description, Holotype. Dissepimentarium in adult stage (35 mm below calyx, corallite diameter 48 mm) of 10 to 17 ranks of steeply dipping cystose dissepiments, smaller at periphery (presumably where minor septa present), larger axially; tabulae in same section mostly flat with downturned edges,

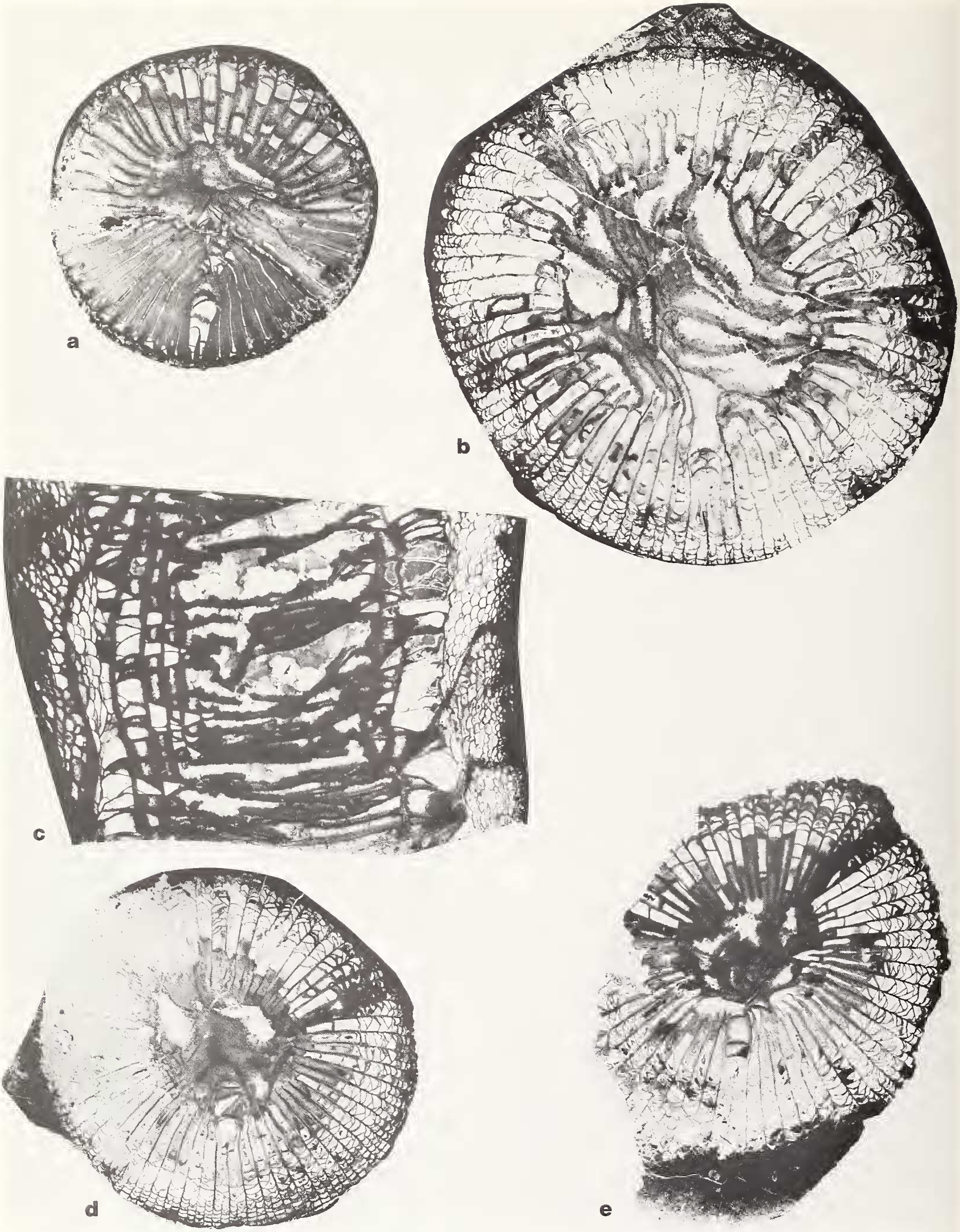


Figure 11. *Gshelia americana* n. sp. All parts x1.5. **Parts a through c,** LACMIP paratype 6348, serial transverse sections (a, b) and longitudinal section (c). **Parts d and e,** LACMIP paratype 6349, serial transverse sections.

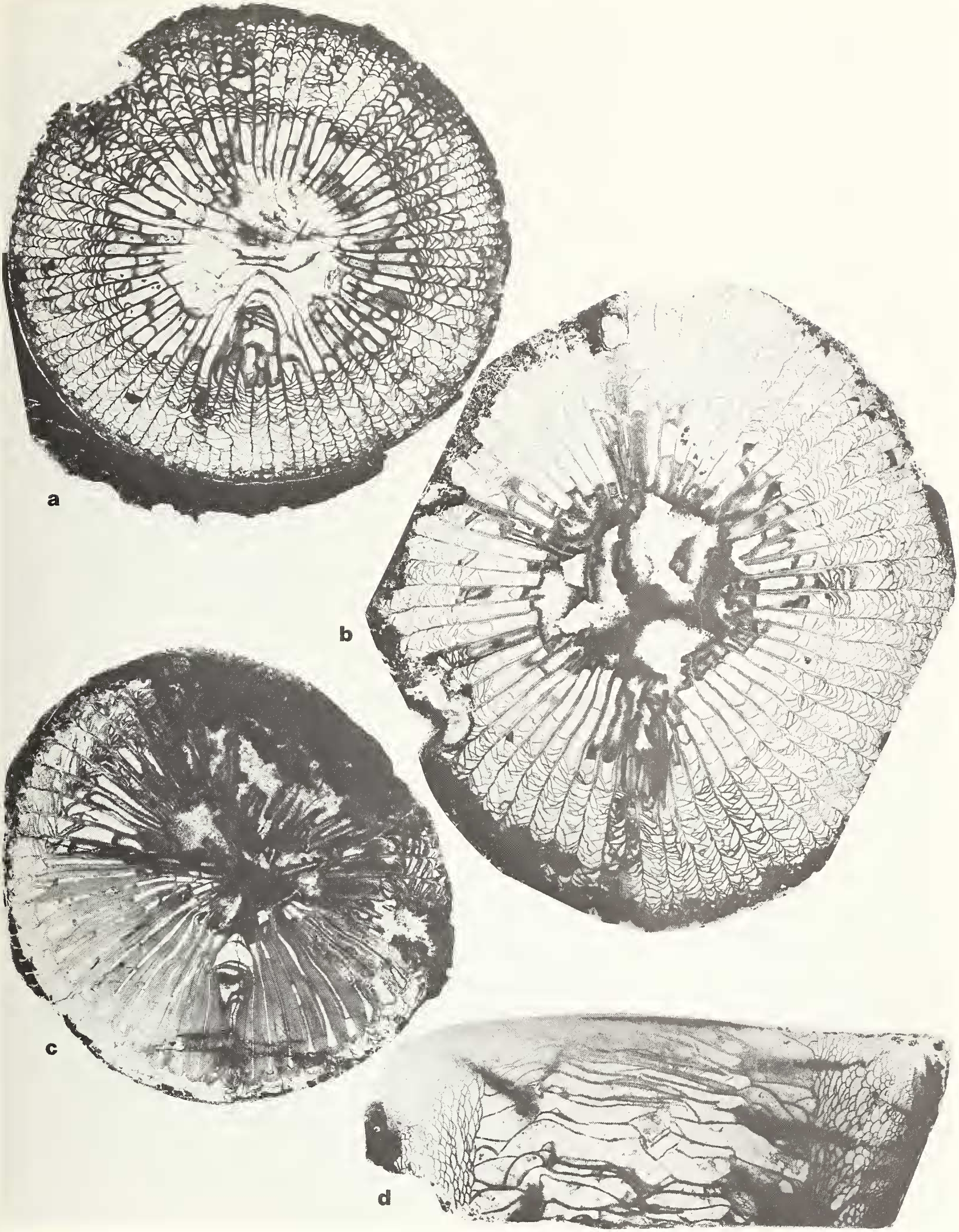


Figure 12. *Gshelia americana* n. sp. All parts x1.5. **Parts a and d,** UCMP paratype 37180, transverse (a) and longitudinal (d) sections. **Part b,** LACMIP paratype 6355, transverse section. **Part c,** UCMP paratype 37182, transverse section.

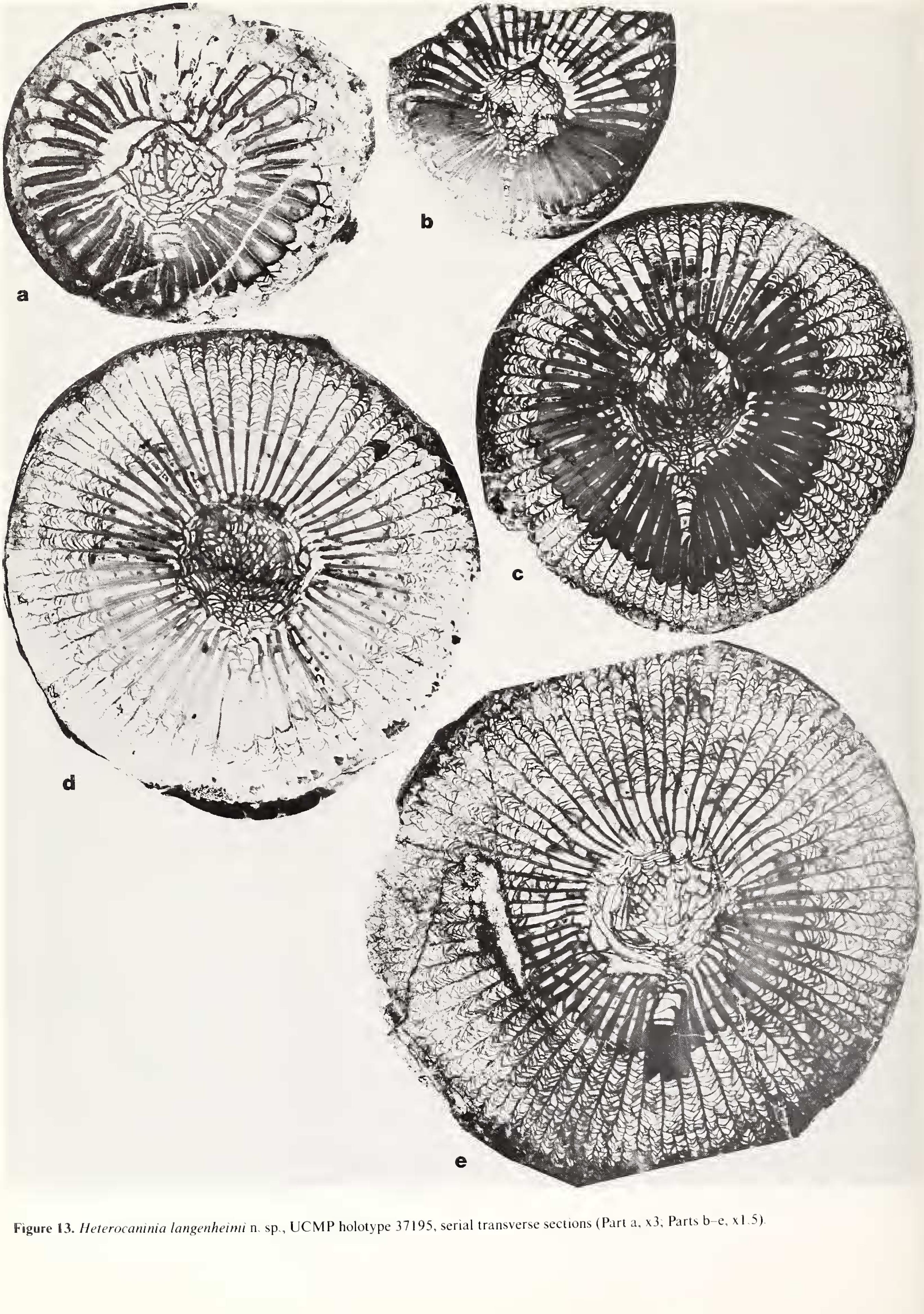


Figure 13. *Heterocaninia langenheimi* n. sp., UCMP holotype 37195, serial transverse sections (Part a, x3; Parts b–e, x1.5).

9 to 12 per cm; tabellae at peripheral edges of some tabulae; wall as in transverse section; longitudinal section of adolescent stage not observed.

Documentation. LACMIP holotype 6347, LACMIP paratypes 6348–6357, UCMP paratypes 37179–37194. Twenty-three thin sections and numerous polished sections from 27 coralla from LACMIP locality 1133 (holotype 6347, paratypes 6348–6357), UCMP localities D-800 (paratypes 37183–37184, 37189), D-819 (paratypes 37185–37187), D-821 (paratype 37179), D-822 (paratype 37188), D-826 (paratypes 37180–37181, 37190), D-831 (paratypes 37191–37193), and D-832 (paratypes 37182, 37194) were studied.

Discussion. This species has all the characters of the genus: earliest stages without axial structures, followed by short interval with axial structures, and adult stages lacking axial structures (Dobrolyubova, 1940:71–81). The McCloud Limestone occurrence is the first record of the genus for North America in the Permian. Schouppe (1961:368) stated that *Gshelia* occurs in the "Unterkarbon . . . Nordamerica" but I have not been able to verify this. Hill (1956:292) listed the range as "M. Carb.-U. Carb., USSR-Spitz.[bergen]," but it also occurs in the Lower Permian of Russia.

Gshelia americana is comparable to the type species, *G. rouilleri* Stuckenberg, 1888, from the Upper Carboniferous of the Moscow Basin, in size, number of septa, development of the axial structure, and some minor features. *G. americana* has, however, minor septa that are confined to the periphery of the dissepimentarium, whereas *G. rouilleri* has minor septa in many coralla that cross the dissepimentarium and may extend slightly into the tabularium.

Schouppe (1961:367) stated that there are four species of *Gshelia* in Spitzbergen: *G. calophylloides* (Holtedahl, 1913), *G. nikitini* (Stuckenberg, 1905), *G. ruprechti* (Stuckenberg, 1895), and *G. lonsdalei* (Keyserling, 1854). These were described and figured by Heritsch (1939:37–57) under the genus *Siphonophyllia* Scouler, 1844. Only *G. nikitini* was shown (Heritsch, 1939:54, pl. 2, fig. 3) to have a juvenile axial structure, and that was a simple columella without the axial lamellae present in the type species of the genus. Although the adult stages resemble those of *Gshelia*, there are other genera so similar that I believe the Spitzbergen species' generic assignment to be in doubt until the juvenile stages are figured adequately.

If, however, these four species should turn out to belong in *Gshelia*, the following differences can be pointed out from *G. americana*. *G.* (?) *nikitini* has a simpler axial structure. *G.* (?) *calophylloides* appears similar in the adult stages but the juvenile stages are unknown, and Heritsch (1939) figured no longitudinal sections so these cannot be compared. *G.* (?) *ruprechti*, as figured by Heritsch (1939, pl. 2, figs. 6, 7; pl. 11, fig. 8) does not exhibit many characters of the genus, is probably not *Gshelia*, and has minor septa that cross the dissepimentarium. *G.* (?) *lonsdalei*, as figured by Heritsch (1939, pl. 3, fig. 2; pl. 19, fig. 15) has long minor septa that cross the dissepimentarium and extend into the tabularium.

G. rouilleri var. *breviseptata* Dobrolyubova and Kabakovich, 1948 (p. 21, pl. 11, figs. 1–9; pl. 12, figs. 1–3; pl. 13, figs. 1–2), from the Upper Carboniferous of the Moscow Basin, has longer minor septa and shorter major septa than *G. americana*.

G. elliptica Chi, 1931 (p. 17, pl. 3, figs. 8a–c), does not belong in this genus and is not comparable to *G. americana*.

Both *Gshelia* (?) sp. of Easton and Melendres (1964:413, figs. 1a–1c), from a clast in a Miocene conglomerate in the Philippine Islands, and *Gshelia* cf. *calophylloides* of Schouppe (1961:368, fig. 4), from the Upper Carboniferous of Yugoslavia, are known from specimens inadequately preserved for close comparison with other species.

Etymology. The species is named for North America.

Genus *Heterocaninia* Yabe and Hayasaka, 1920

Heterocaninia langenheimi n. sp.

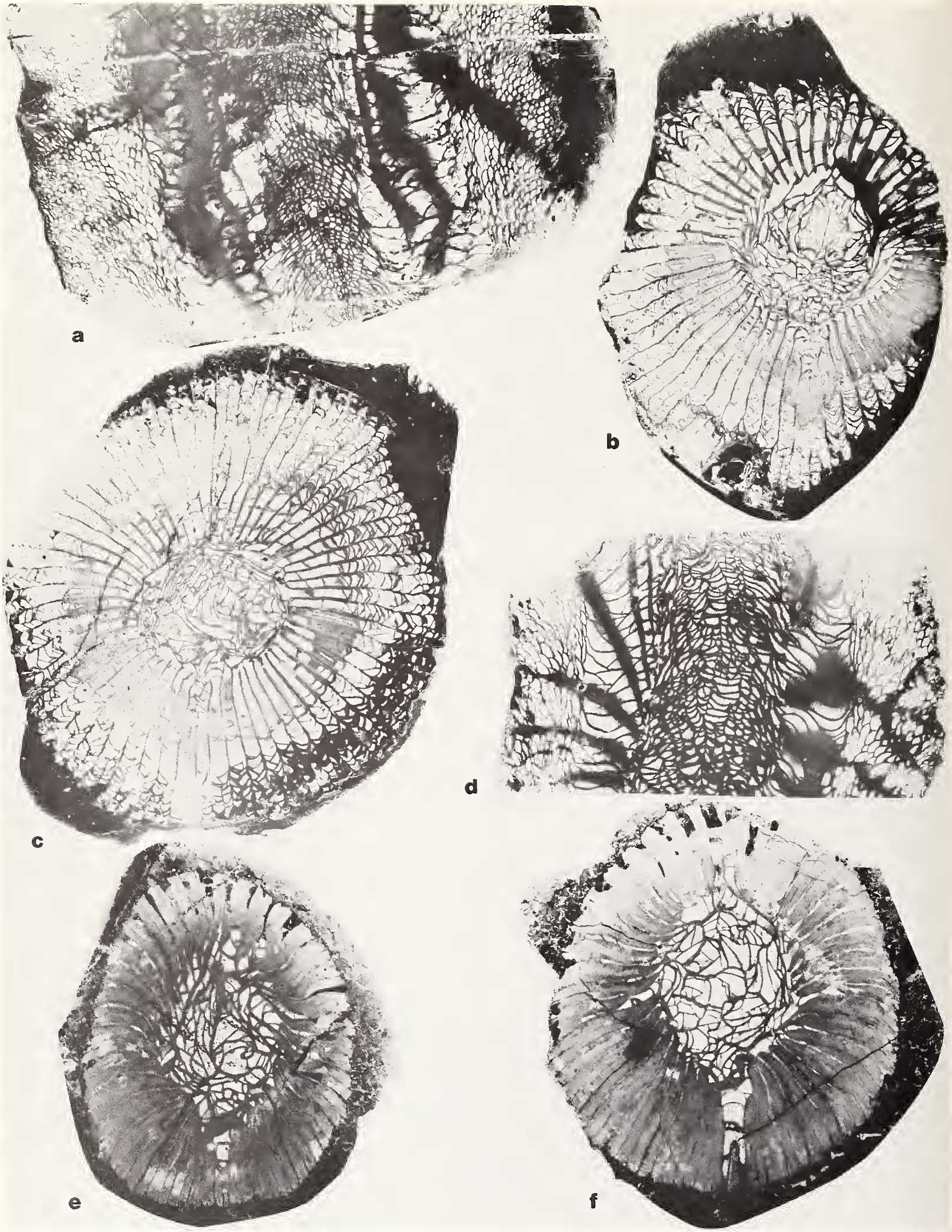
Figures 13a–e; 14a–d

Diagnosis. A species of *Heterocaninia* characterized by the combination of very large corallites, a modest number of septa, and well-developed minor septa in the dissepimentarium. It has much larger corallites, fewer septa, and better developed minor septa than *H. tholusitabulata*.

External Description. Corallites solitary, large, trochoid becoming cylindrical, maximum observed length 36 cm, maximum observed diameter 7.6 cm; corallite wall transversely lined and wrinkled, larger wrinkles (rugae) about 1 to 2 cm apart, fine transverse lines number about 30 in 1 cm vertically along corallite.

Transverse Section Description. Corallites roughly circular, diameters to 7.6 cm (generally between 6 and 7 cm); major septa well developed, dilate in cardinal quadrants in tabularium throughout ontogeny, thin in dissepimentarium, thinner in counter quadrants in tabularium but somewhat dilated there in juvenile stages; major septa in holotype number 36 at 23 mm, 43 at 35 mm, 52 at 54 mm, 52 at 57 mm, 57 at 68 mm; septa number 74 in largest (74-mm) paratype, UCMP 37196; cardinal septum short; septa number 24 in youngest observed (diameter 11 mm) paratype, 6359; minor septa well developed, at 11-mm corallite diameter crossing dissepimentarium (2 ranks) and few entering tabularium as nubs on inner wall, in adult stages confined to outer ½ to ⅔ of dissepimentarium; axial structure large, variable, clisiophylloid in juvenile stages, clisiophylloid or aulophylloid in adult stages, occupying most of tabularium, regular to irregular, with relatively few septal lamellae abutting straight to sinuous medial plate and connected by axial tabellae; dissepimentarium well developed, as much as 1.5 to 2 cm wide in adult stages; dissepiments highly variable, herringbone, pseudoherringbone, concentric, angulo-concentric, and (in largest adult stages) with some small lateral cystose ones alongside some septa; false wall developed axially on row of dissepiments bordering tabularium in some corallites, thickest in cardinal quadrants and juvenile to early adult stages; corallite wall very thin, 0.1 to 0.15 mm thick, silicified.

Longitudinal Section Description. Dissepimentarium of 12 to 23 ranks of steeply to very steeply dipping cystose to elongate, small to large dissepiments, generally more cystose peripherally, more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elongate axially; tabellae of 2 series: axial and periaxial; axial tabellae gently domed inwards and upwards towards and around medial plate and/or septal lamellae, about 15 in 1 cm; periaxial tabellae in 1 or 2 series, horizontal, sagging, or sloping inwards and upwards generally to axial tabellae.

Documentation. UCMP holotype 37195, UCMP paratypes 37196–37202, 37283, LACMIP paratypes 6358–6373. Nine thin sections and numerous polished sections from 24 coralla from UCMP localities D-819 (paratypes 37200–37202), D-822 (paratypes 37196, 37198–37199, 37283), D-826 (paratype 37197), and D-831 (holotype 37195) and LACMIP localities 1132 (paratypes 6366–6370), 1133 (paratypes 6359–6365, 6371–6373), and 4458 (paratype 6358) were studied.

Discussion. Genera of many large solitary Upper Paleozoic corals are badly in need of reinvestigation and redefinition. This coral does not fit readily into any of them. I have chosen to place it in *Heterocaninia* because the type species, *H. tholusitabulata* Yabe and Hayasaka, 1920, from the Lower Carboniferous of China, has distinctly dilated septa in the cardinal quadrants and a similar appearing axial structure, whereas other genera of the Aulophyllidae and Cyathopsidae with somewhat similar characters do not have such pronounced cardinal quadrant septal dilation. Hill (1956:290) stated that *Heterocaninia* has "minor septa absent," but Cotton (1973:95) reported ". . . minors very short and in weathered specimens may not be observed." *H. langenheimi* has minor septa that do not cross the dissepimentarium in postjuvenile stages, and some specimens have parts of the coral that contained these weathered away.

The genus has not been heretofore recorded in North American Permian rocks. The size and other characters clearly distinguish *H. langenheimi* from any previously described Permian coral.

The specimens occur in growth positions in "log jam" abundance in beds with *Gshelia americana.* The shape of the cylindrical corallum is twisted in many specimens, even as much as 360° in very long specimens, and many specimens exhibit sharp angles (as much as 90°), suggesting that they may have grown upwards until top heavy, fallen over, and then resumed upward growth. Calices of most specimens face towards the upper bedding plane surfaces. Internal structures, such as the cardinal fossula, are randomly oriented to the external curvature of the corallites, which is in contrast to observations made of some other solitary corals.

Etymology. The species is named for Dr. R.L. Langenheim, Jr.

Heterocaninia (?) sp.

Figures 14e–f

Transverse Section Description. Corallite solitary, circular to subcircular, maximum observed diameter 29 mm (dissepimentarium missing); major septa number 38 at 20-mm corallite diameter, 41 at 22-mm corallite diameter, all lanceolate and highly dilate, 6 to 7 mm long in tabularium, many touching axial structure and continuous with septal lamellae; cardinal septum shortened, about 1 mm long in tabularium; cardinal fossula closed; minor septa not observed; dissepimentarium not present due to eroded surface of corallite; axial structure large, filling entire tabularium, composed of highly sinuous medial plate (?) and septal lamellae, many formed from attenuate ends of septa, joined by tabellae; corallite wall not observed.

Documentation. UCMP hypotype 37203. Two thin sections and six polished sections from one corallum from UCMP locality D-861 were studied. Fragments of other corallites were present in the rock.

Discussion. This coral occurs with *Clisiophyllum gabbi* Meek, 1864, which has fewer and much thinner septa and a better defined axial structure. The extreme dilation of all the septa and the nature of the axial structure clearly distinguish *Heterocaninia* (?) sp. from other species found in the McCloud Limestone. It somewhat resembles *?Clisiophyllum* sp. B of Rowett, 1969 (p. 58, pl. 7, fig. 3) from the Lower Permian of Alaska, but Rowett's specimen has a greater number of septa and an open cardinal fossula.

The generic referral is questionable since the dissepimentarium was not preserved and no longitudinal section was obtainable. Probably the coral represents a late neanic stage.

Fasciculate Rugosa

Genus *Durhamina* Wilson and Langenheim, 1962

Durhamina sublaeve (Meek, 1864)

Figures 5:4, 4a, 4b; 15a–c; 16a–e

Lithostrotion mamillare (?), Castlenau, (sp.). Meek, 1864:5 (*pars*), pl. 1, figs. 4, 4a, 4b.

L. sublaeve Meek, 1864:6 (*pars*), pl. 1, figs. 4, 4a, 4b.

Lithostrotion mamillare, var. *sublaevis* Meek, 1864, legend pl. 1, figs. 4, 4a, 4b.

Lithostrotion ____*?* Meek, 1864:7 (not figured).

Not *Lithostrotion mamillare?* of Meek, 1864, pl. 1, figs. 3, 3a.

External Description. Corallum phaceloid, maximum observed diameter 15 cm; epitheca with distinct, closely spaced rugae; calyx not observed.

Transverse Section Description. Corallites circular, diameter 10 to 12 mm, touching to as much as 20 mm distant; septa of 2 orders, 19 to 23 each, thin, straight, or slightly sinuous; major septa 2.5 to 4 mm long, generally all but 1 or 2 withdrawn from axial structure; minor septa 0.2 to 1.0 mm long, well developed; dissepimentarium regular, 1 to 3 mm wide; dissepiments concentric, angulo-concentric, straight, or herringbone; axial structure aulophylloid where most fully developed, with very sinuous medial plate (not everywhere distinguishable from axial tabellae) and an indeterminable number of highly sinuous septal lamellae, generally withdrawn from septa except in some corallites 1

Figure 14. *Heterocaninia langenheimi* n. sp. and *Heterocaninia* (?) sp.

Parts a through d. *H. langenheimi* n. sp., all parts x1.5. **Part a,** UCMP holotype 37195, longitudinal section. **Parts b through d,** UCMP paratype 37196, serial transverse sections (b, c) and longitudinal section (d).

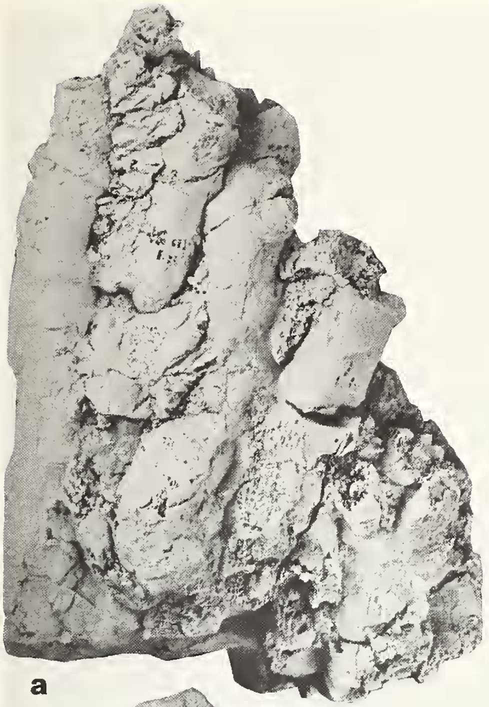
Parts e and f. *Heterocaninia* (?) sp., UCMP hypotype 37203, serial transverse sections, x3.

Figure 15. *Durhamina sublaeve* (Meek, 1864), *Heritschioides* (?) *californiense* (Meek, 1864), and *Kleopatrina (Porfirievella) whitneyi* n. sp.

Parts a through c. *D. sublaeve*, all parts x1. **Part a,** MCZ holotype, MCZ Meek collection corallum no. 17, figured by Meek (1864, pl. 1, fig. 4). **Part b,** MCZ hypotype, MCZ Meek collection corallum no. 16, labeled "*Lithostrotion* ___" by Meek. **Part c,** MCZ hypotype, MCZ Meek collection corallum no. 14, labeled "*Lithostrotion* ___" by Meek.

Parts d and e. H. (?) *californiense*. **Part d,** MCZ lectotype (arrow), paralectotypes, MCZ Meek collection block no. 13, x0.5. **Part e,** lectotype, detail of Part d, figured by Meek (1864, pl. 1, fig. 2b), x1.

Part f. *K.*(*P.*) *whitneyi* n. sp., MCZ holotype, MCZ Meek collection corallum no. 15, figured by Meek (1864, pl. 1, fig. 3), x1.5.



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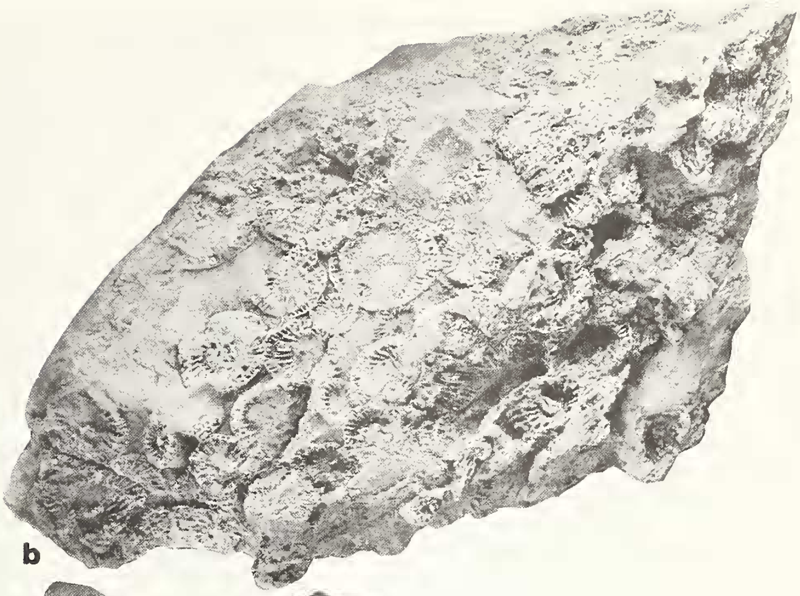

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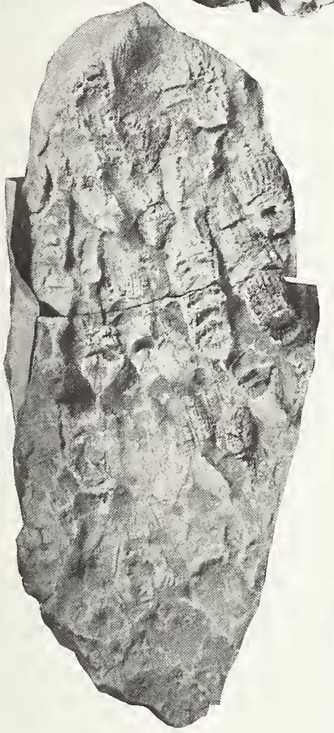

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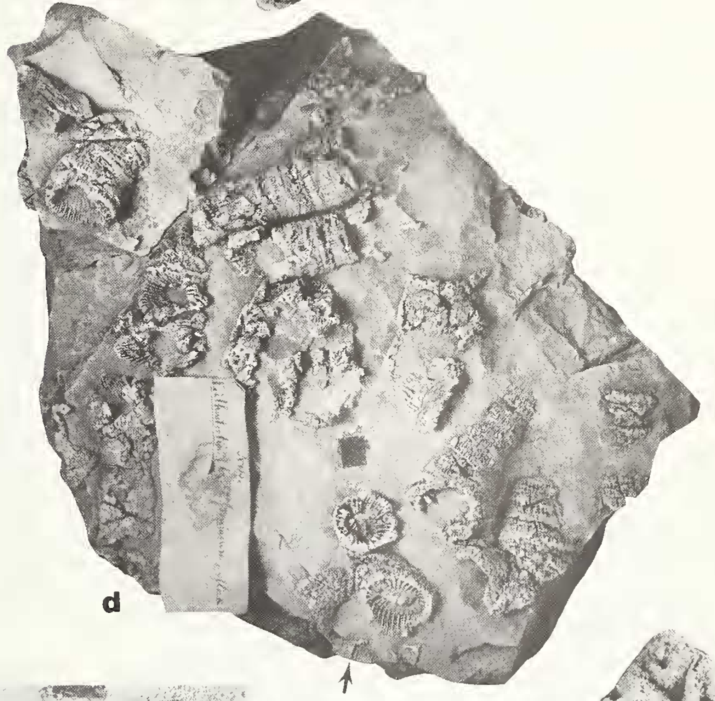

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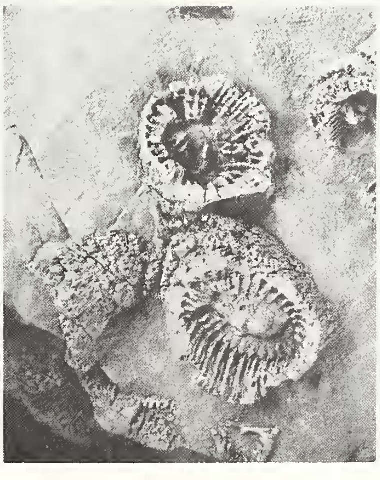

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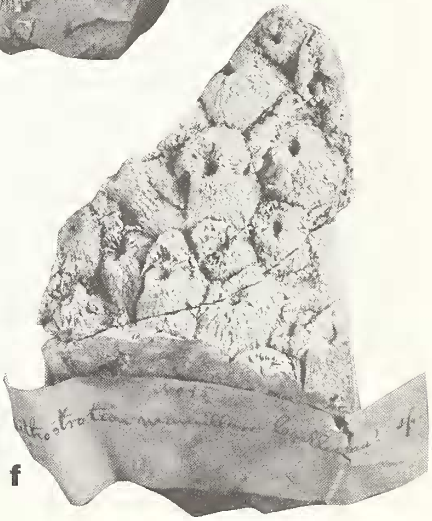

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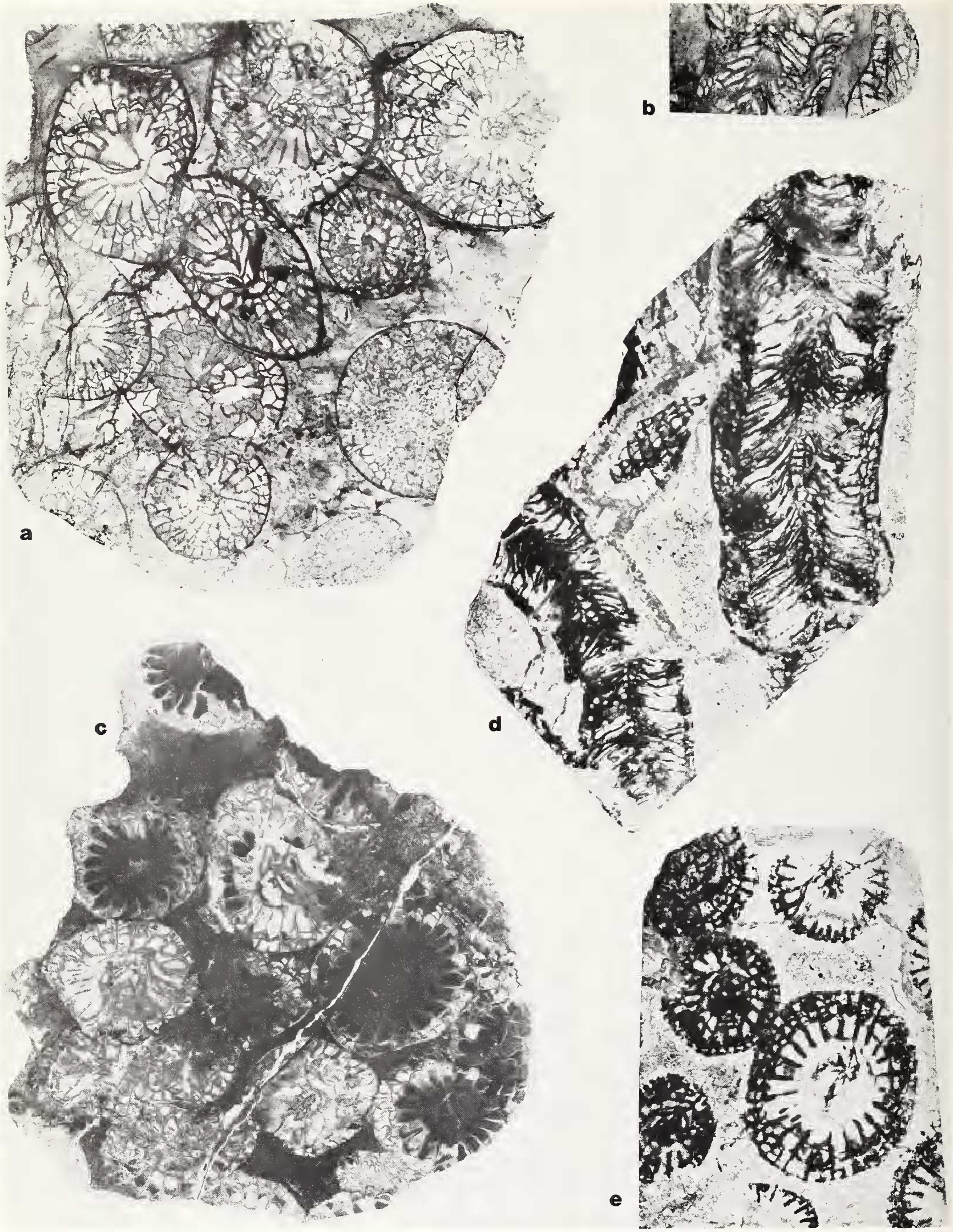


Figure 16. *Durhamina sublaeve* (Meek, 1864). All parts x3. **Parts a and b,** MCZ holotype, MCZ Meek collection corallum no. 17, transverse (a) and longitudinal (b) sections. **Part c,** MCZ hypotype, MCZ Meek collection corallum no. 14, transverse section. **Parts d and e,** MCZ hypotype, MCZ Meek collection corallum no. 16, longitudinal (d) and transverse (e) sections.

(counter?) or 2; medial plate attached to 1 septum present in some corallites without septal lamellae; corallite wall very thin, 0.1 to 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 4 ranks of various sized (none highly inflated) dissepiments; tabellae of 2 loosely defined ranks, axial and periaxial, both inclined inwards and upwards to medial plate; tabulae tent-shaped where ranks of tabellae break down.

Documentation. Meek's (1864, pl. 1, figs. 4, 4a, 4b) figured specimen is recognized here as the holotype in accordance with ICZN article 73(a): "If a nominal species is based on a single specimen, that specimen is the 'holotype.' " The specimen is no. 17 in the MCZ collection and the only one labeled *Lithostrotion sublaeve.* I prepared two thin sections from it. MCZ specimens nos. 14 and 16 are referred here to *Durhamina sublaeve.* I prepared one thin section of the former and two of the latter. Nos. 14 and 16 were labeled "*Lithostrotion* ____?" and apparently were used by Meek for his description (Meek, 1864:7) under that designation. They are fasciculate, as Meek reported, although a cerioid corallum was figured erroneously by him (Meek, 1864, pl. 1, figs. 3, 3a) with this name.

Discussion. The type locality, as with the other Meek (1864) McCloud Limestone specimens, is presumed to be somewhere in the formation south of the Pit River. Since I did not encounter additional specimens of the species in my field work and since diagnostic fusulinids were not found in the matrix remaining on Meek's coralla, the exact stratigraphic position is uncertain. In this area, the McCloud Limestone is within fusulinid zone E and zone F.

Rowett (1969:43) published a key for eight species of *Durhamina. D. sublaeve* compares closely only with *D. cordillerensis* (Easton, 1960) from the Permian of east-central Nevada and southern California and with *D. alaskaensis* Rowett, 1969, from the Permian of Alaska. All three species have "axial tabellae not highly cystose at maturity" and "comparatively small corallites with few speta." *D. cordillerensis,* type species of the genus, is similar to *D. sublaeve,* but the former has a more complex axial structure where most fully developed, with more major septa touching it and more lonsdaleoid dissepiments. *D. alaskaensis* has somewhat larger corallites and a greater number of septa than *D. sublaeve.*

Genus *Heritschioides* Yabe, 1950

***Heritschioides carneyi* n. sp.**

Figures 18a–c

Diagnosis. A species of *Heritschioides* characterized by the combination of large corallites, a large number of septa, a simple axial structure, and minor septa generally confined to the dissepimentarium. It has larger corallites than *H. buttensis, H. summitensis, H. parvum,* and *H. stevensi.* It has shorter minor septa than *H. hammani, H. merriami, H. wexoi, H. columbicum, H. coogani, H. durhami, H. rowetti, H. washburni, H. wildei, H. gavini,* and *H. smithi.* It has a simpler and more symmetrical axial structure than *H. hillae, H. moormanensis, H. ochocoensis,* and *H. skinneri.*

External Description. Corallum phaceloid, hemispheroidal, maximum observed diameter 18 cm; corallites subparallel, closely spaced to touching; epitheca and calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 12 to 18 mm, closely spaced, touching to as much as 11 mm apart; septa of 2 orders, 25 to 29 each, straight to broadly sinuous, generally thin in dissepimentarium (0.1 to 0.2 mm wide), dilate in tabularium (about 0.3 mm at base) becoming attenuate axially; major septa withdrawn from axial structure (except counter? septum in some), 4 to 6 mm long, except shortened cardinal septum 3 to 5 mm long; minor septa well developed, 1.3 to 2.4 mm long, generally confined to peripheral part of dissepimentarium, some crossing dissepimentarium, few entering tabularium as short spines; fossula small, open, formed by shortened cardinal septum; dissepimentarium regular or herringbone; stereozone developed on some dissepiments separating dissepimentarium from tabularium; axial structure clisiophylloid, generally simple and asymmetrical, relatively small, elliptical to subcircular, dimensions 1 by 3 mm to 3.5 by 4.5 mm; medial plate well developed, straight to sinuous, dilate, width 0.2 to 0.25 mm, length 2 to 4 mm; 2 to 10 sinuously and irregularly developed septal lamellae present; axial tabellae generally few, connecting septal lamellae in somewhat asymmetrical spiderweb pattern; corallite wall about 0.2 to 0.3 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 5 (generally 3 to 4) steeply dipping ranks of large and small cystose dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae small, cystose, dipping inwards and upwards to medial plate; periaxial tabellae variously developed, about 15 per cm, generally 1 or 2 ranks sloping inwards and upwards to axial tabellae, but outer ones may be variously inclined to flat; tabulae present where axial structure consists only of medial plate.

Documentation. LACMIP holotype 6374, LACMIP paratype 6375. Six thin sections and 65 polished sections from two coralla from LACMIP locality 4457 were studied.

Discussion. *H. carneyi* differs from other species of the genus that have similar sized corallites and similar numbers of septa by possessing a variable axial structure that generally is extremely simple with few axial lamellae and by possessing minor septa that generally are confined to the dissepimentarium and appear only as spines in the few instances that they reach the tabularium. These relationships are shown graphically for this and other species in the genus on Figure 17, which informally and artificially combines species of *Heritschioides* based on four readily observable characters.

H. carneyi may be the oldest species of the genus recognized thus far. All other species in the McCloud Limestone are stratigraphically higher than *H. carneyi,* as are the species described from Permian rocks in Oregon, Nevada, and most probably Alaska. The exact stratigraphic position of the type species, *H. columbicum* Smith, 1935, is uncertain however (Wilson, 1980:90).

Ockentorp et al. (1978:387) figured a coral from the Upper Permian of Oman and referred it to *H. columbicum.* It should be examined again for characters of the genus. Wilson (1980) considered reports of *Heritschioides* from rocks outside western North America to be doubtful.

Watkins (1973:1761) cited C.H. Stevens as having identified a coral from the Hirz Mountain Limestone member of the Baird

		CORALLITE DIAMETERS GENERALLY LESS THAN 10 MM		CORALLITE DIAMETERS GENERALLY MORE THAN 10 MM	
		AXIAL STRUCTURE SYMMETRICAL OR VERY SIMPLE	AXIAL STRUCTURE ASYMMETRICAL	AXIAL STRUCTURE SYMMETRICAL OR VERY SIMPLE	AXIAL STRUCTURE ASYMMETRICAL
MINOR SEPTA GENERALLY EXTEND INTO TABULARIUM	**MAXIMUM NUMBER OF MAJOR SEPTA 25 OR FEWER**	H. buttensis		H. hammani H. merriami H. wexoi	
	MAXIMUM NUMBER OF MAJOR SEPTA MORE THAN 25	H. summitensis		H. columbicum H. coogani H. durhami H. rowetti H. washburni H. wildei H. woodi	H. gavini H. smithi
MINOR SEPTA GENERALLY DO NOT EXTEND INTO TABULARIUM	**MAXIMUM NUMBER OF MAJOR SEPTA 25 OR FEWER**	H. parvum H. stevensi			
	MAXIMUM NUMBER OF MAJOR SEPTA MORE THAN 25			H. carneyi	H. hillae H. moormanensis H. ochocoensis H. skinneri

Figure 17. Informal combinations of *Heritschioides* species based on corallite diameters, numbers of major septa, lengths of minor septa, and symmetry of axial structures.

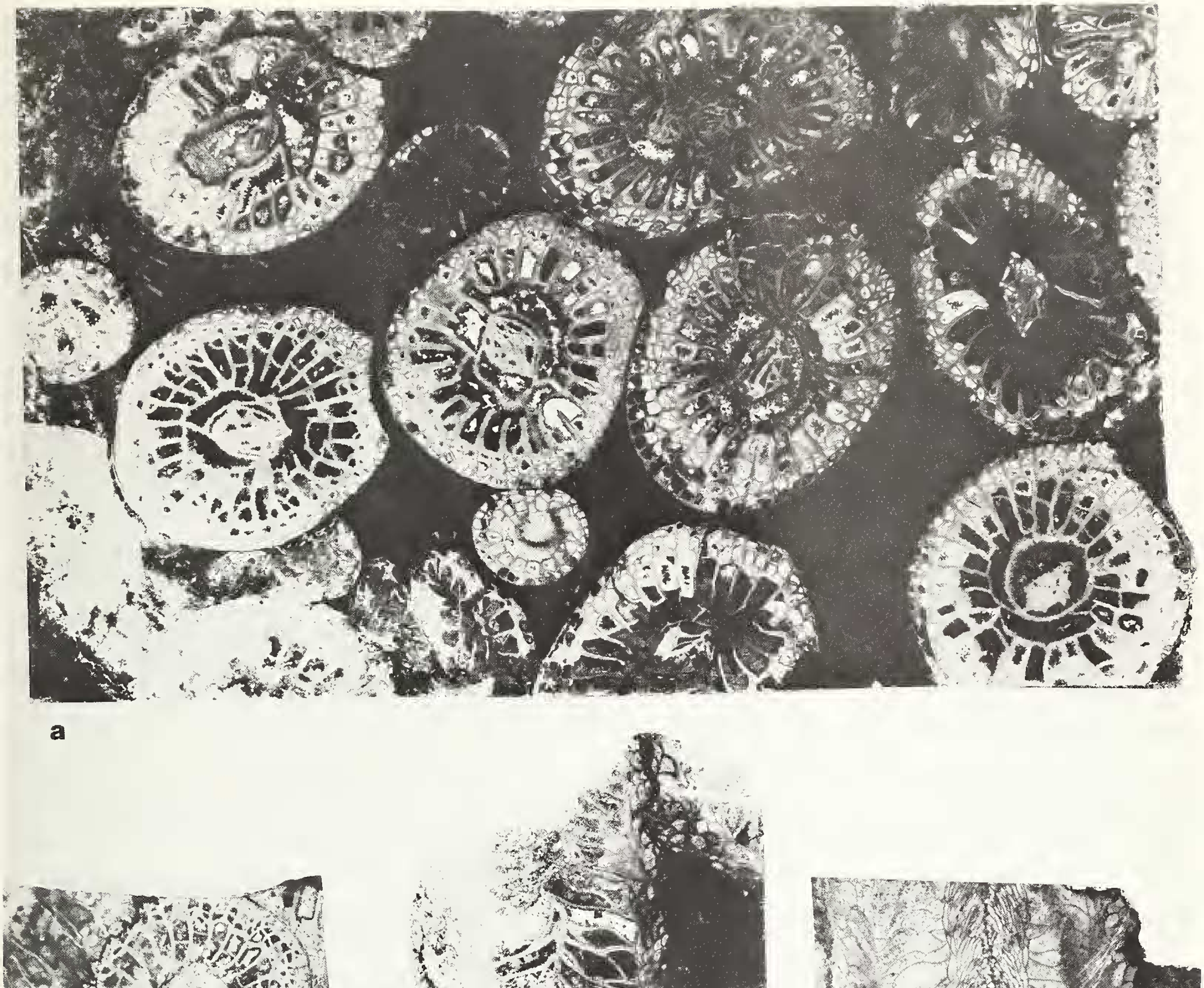


Figure 18. *Heritschioides carneyi* n. sp. and *H. coogani* n. sp. All parts x3.
Parts a through c. *H. carneyi* n. sp., LACMIP holotype 6374, transverse (a, b) and longitudinal (c) sections.
Part d. *H. coogani* n. sp., LACMIP paratype 6379, longitudinal section.

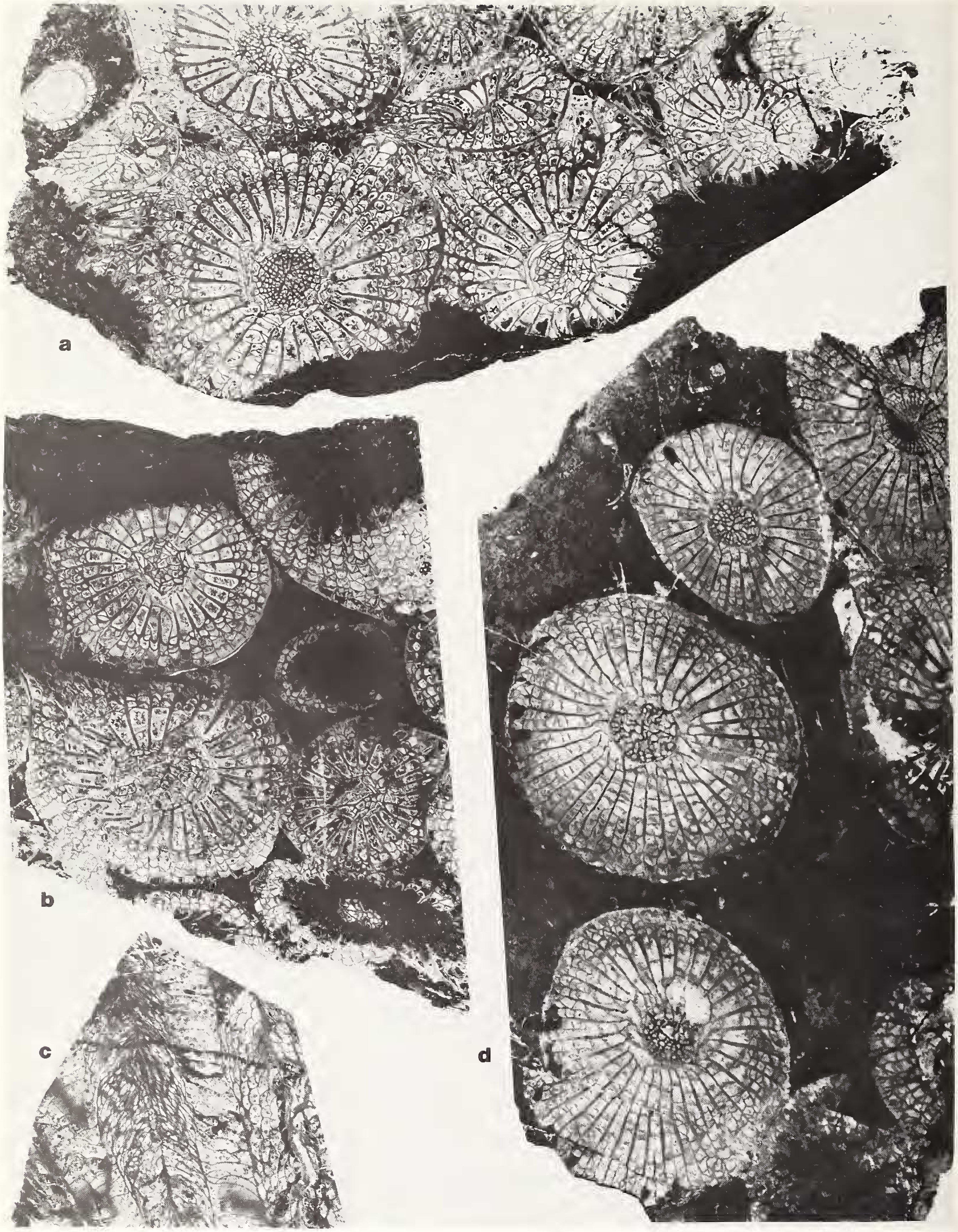


Figure 19. *Heritschioides coogani* n. sp. All parts x3. **Parts a through c,** LACMIP holotype 6376, transverse (a, b) and longitudinal (c) sections. **Part d,** LACMIP paratype 6379, transverse section.

Formation on Hirz Mountain as *Heritschioides* sp. This is below the McCloud Limestone and Pennsylvanian or Permian in age (Watkins, 1973:1743). I have not seen this coral.

Etymology. The species is named for Mr. William Alderman Carney.

Heritschioides coogani n. sp.

Figures 18d, 19a–d

Diagnosis. A species of *Heritschioides* characterized by the combination of relatively long and thin septa, a symmetrical and complex axial structure, large corallites, and a large number of major septa. It has thinner minor septa and a more symmetrical axial structure than *H. columbicum.* It has smaller corallites, a more regular axial plate, and shorter minor septa than *H. durhami.* It has larger corallites, more numerous septa, and a more complex axial structure than *H. washburni.* It has more and better developed septal lamellae than *H. wildei.* It has thinner and more numerous septa, shorter minor septa, and more numerous and less sinuous septal lamellae than *H. woodi.*

External Description. Corallum phaceloid, hemispheroidal, maximum observed diameter 12 cm, height 10 cm; corallites parallel to subparallel, very closely spaced (some nearly cerioid); epitheca and calyx not observed.

Transverse Section Description. Corallites circular to subcircular (some angular in part where corallite nearly cerioid), closely spaced, diameter 15 to 19 mm; septa of 2 orders, 25 to 33 each, straight to slightly sinuous, thin in dissepimentarium (about 0.1 mm wide), dilate in tabularium (0.2 to 0.3 mm at base) becoming attenuate axially; major septa touching or slightly withdrawn from axial structure, 6 to 10 mm long (generally 6 to 8), except shortened cardinal septum 4 to 6 mm long; minor septa well developed, 2 to 5.5 mm long, crossing dissepimentarium, many entering tabularium as nubs or dilate septa as much as 1 mm long; fossula small, open, formed by shortened cardinal septum, 1 to 1.5 mm deep; dissepimentarium regular, with dissepiments concentric, angulo-concentric, pseudoherringbone, or concave outwards; stereozone developed on some dissepiments separating dissepimentarium from tabularium; axial structure clisiophylloid, large, complex, symmetrical, generally circular, diameters 3 to 5 mm; medial plate well developed, 3 to 5 mm long, thin or dilate, straight to sinuous, connected to counter septum in some corallites; septal lamellae numerous, 13 to 26, rather evenly developed opposite one another in most complex axial structures; axial tabellae in 3 to 6 ranks, connecting septal lamellae in symmetrical spider-web pattern in best developed axial structures; corallite wall about 0.2 mm wide, rarely fused in closely spaced corallites to form joint cerioid-type wall.

Longitudinal Section Description. Dissepimentarium wide, of 4 to 6 ranks of steeply dipping cystose dissepiments (transverse sections indicate more ranks in some areas of corallites); tabellae of 2 well-defined zones, axial and periaxial; axial tabellae small to large, cystose to straight, dipping inwards and upwards to medial plate in 1 to 6 ranks; periaxial tabellae in 1 to 3 ranks, straight to gently domed, dipping inwards and upwards to axial tabellae.

Documentation. LACMIP holotype 6376, LACMIP paratypes 6377–6379. Six thin sections and 54 polished sections from four coralla from LACMIP locality 1119 were studied.

Discussion. *H. coogani* is comparable to six other species, as can be seen in Figure 17. *H. wildei* n. sp. is somewhat similar but has far fewer septal lamellae that are less regularly developed on each side of the axial plate. *H. durhami* n. sp. has larger corallites, longer minor septa, and a less regular axial plate. *H. rowetti* n. sp. has much smaller corallites and fewer septa. *H. columbicum* (Smith, 1935), the type species from British Columbia, has longer minor septa that are more dilate and a somewhat less symmetrical axial structure. *H. washburni* (Merriam, 1942), from the Permian Coyote Butte Formation of Oregon, has more septa, larger corallites, and a somewhat smaller and simpler axial structure. *H. woodi* Wilson and Langenheim, 1962, from the Permian (Leonardian) Arcturus Formation of eastern Nevada, has longer minor septa, fewer and more sinuous septal lamellae, and somewhat fewer septa.

Etymology. The species is named for Dr. Alan H. Coogan.

Heritschioides durhami n. sp.

Figures 20a–b

Diagnosis. A species of *Heritschioides* that has larger corallite diameters than any other species in the genus.

External Description. Corallum phaceloid and fragmentary, maximum observed diameter 11 cm; epitheca highly silicified, weathered; calyx not observed.

Transverse Section Description. Corallites circular, diameters very large, 17 to 34 mm, touching to as much as 7 mm apart; septa of 2 orders, 26 to 29 each, straight to somewhat sinuous, thin in dissepimentarium (about 0.1 mm), dilate in tabularium (about 0.24 to 0.4 mm); major septa very slightly withdrawn from axial structure (some bent axially near axial structure), 5 to 8 mm long, except shortened cardinal septa (1.7 to 3.2 mm long); minor septa very well developed, 1.7 to 3.2 mm long, extending across dissepimentarium and well into tabularium (about 0.5 mm); fossula small, open; dissepimentarium regular, 2 to 4 mm wide; dissepiments generally angulo-concentric, less generally herringbone, concentric, or straight; stereozone on axial row of dissepiments absent or very inconspicuous; axial structure clisiophylloid, rather symmetrical, large, circular, diameter 5 to 8 mm; medial plate inconspicuous, not dilate; septal lamellae thin, variously developed, 18 to 31, sinuous, curved, or straight, not all traversing axial structure to medial plate; axial tabellae very numerous, generally straight between septal lamellae; corallite wall about 0.1 to 0.15 mm wide, with septa inserted in V-shaped depressions.

Longitudinal Section Description. Dissepimentarium wide, of 4 to 10 ranks of steeply dipping, various sized dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae of various sizes, cystose to elongate, dipping steeply inwards and upwards to medial plate in 5 to 6 ranks on each side; periaxial tabellae cystose to straight, sloping inwards and upwards to axial tabellae in 2 to 3 ranks.

Documentation. LACMIP holotype 6380. Two thin sections and 13 polished sections from one corallum from LACMIP locality 1125 were studied.

Discussion. The corallite diameters of *H. durhami* are much larger than those of any other species yet recorded for the genus. A 20-mm diameter is large for any species of *Heritschioides*, but one corallite in this corallum is 34 mm in diameter and the others are 20 mm or more. This alone should clearly distinguish it from other species. In addition, the combination of a large number of septa (as many as 29), the great length of the minor septa, the complex and regularly shaped large axial structure with its thin medial plate distinguishes it from *H. wildei*, which occurs in the same unit and has a similar number of septa, *H. skinneri*, which is much smaller and has much shorter minor septa, and other species with a similarly large number of septa.

Etymology. The species is named for Dr. J. Wyatt Durham.

Heritschioides gavini n. sp.

Figures 20c–d, 21 a–e

Diagnosis. A species of *Heritschioides* characterized by the combination of large corallites, a large number of septa, long minor septa, and an asymmetrical axial structure. It has larger corallites, more septa, and longer minor septa than *H. smithi*.

External Description. Corallum phaceloid, hemispheroidal, maximum observed diameter 27 cm; corallites subparallel, touching to as much as 1.5 cm apart; calyx 19 mm deep in corallite 24 mm in diameter, with large central axial boss; epitheca not observed.

Transverse Section Description. Corallites circular to subcircular, diamters 21 to 27 mm, generally closely spaced or touching; septa of 2 orders, 34 to 36 each, straight to somewhat sinuous, generally thin in dissepimentarium (about 0.2 mm wide), rarely dilate in dissepimentarium (about 0.4 mm wide), dilate in tabularium (0.2 to 0.4 mm wide); major septa slightly withdrawn or touching axial structure, 6 to 8 mm long, except shortened cardinal septum 3.5 to 4 mm long; minor septa well developed, 3.5 to 5 mm long, crossing dissepimentarium and entering tabularium 0.5 to 2 mm; fossula small, open (rarely closed by neighboring septa), formed by shortened cardinal septum; dissepimentarium regular (rarely lonsdaleoid where 1 or 2 septa fail), generally 3 to 4 mm wide; dissepiments pseudoherringbone, concentric, angulo-concentric, or straight; stereozone separating tabularium from dissepimentarium; axial structure clisiophylloid, large, diameter 5 to 8 mm, circular to subcircular, complex, generally asymmetrical (rarely symmetrical), with sinuous medial plate (straight in neanic stages), numerous (15 to 30) septal lamellae crossing several ranks of axial tabellae (rarely all structures coated with stereoplasm); corallite wall about 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium of 3 to 9 (generally 4 to 5) ranks of steeply dipping small globose and few elongate dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae of 4 to 5 ranks, steeply dipping inwards and upwards to axial tabellae, also some flat, horizontal, or sloping inwards and downwards (rare "clinotabellae").

Documentation. LACMIP holotype 6381, LACMIP paratypes 6382–6388. Seven thin sections and 78 polished sections from eight coralla from LACMIP locality 1285 were studied.

Discussion. *H. gavini* has corallites among the largest in diameter in the genus. *H. durhami* also has large corallites (17- to 34-mm diameters) but fewer septa (26 to 29) as well as other differences, including an essentially symmetrical axial structure. *H. smithi* has corallites much smaller in diameters (15 to 21 mm) and fewer septa (26 to 32), although it also has an essentially asymmetrical axial structure. *H. washburni* (Merriam, 1942:375, pl. 55, figs. 2, 5, 7, 9, 11, 13) would seem similar according to the description, but examination of the type specimens (USNM 143427–143431) confirms that they are smaller (largest corallite diameter about 20 mm), although the numbers of major septa (33 to 35) are close, and the axial structure on some specimens is rather asymmetrical but less so than in *H. gavini*. The species is not closely comparable with any other species.

Preservation of the corallites is not good. The beds have been partly metamorphosed, and there is some crushing in most corallites. *Omphalotrochus* sp. was barely discernible as a "ghost" in the same unit. Cerioid rugose corals also were present but impossible to collect.

Etymology. The species is named for Mr. Peter T. Gavin.

Heritschioides hammani n. sp.

Figures 22a–e

Diagnosis. A species of *Heritschioides* characterized by the combination of relatively small corallites, a simple axial structure, long minor septa, and a small number of major septa. It has smaller corallites and a simpler axial structure than *H. merriami* and *H. wexoi* and straighter septal ends than *H. wexoi*.

External Description. Corallum phaceloid, maximum observed diameter 10 cm; corallites parallel, closely spaced; epitheca and calyx not observed.

Transverse Section Description. Corallites circular, diameter 10 to 12 mm, touching or as much as 5 mm apart; septa of 2 orders, 19 to 23 each, dilate in tabularium (many also dilate in dissepimentarium), straight to slightly sinuous; major septa 2.5 to 4.5 mm long, except cardinal septum about 2 mm long, generally slightly withdrawn from axial structure, except counter septum, which may touch axial structure in some; minor septa well developed, 0.5 to 1.5 mm long, generally extending slightly into tabularium as spines; fossula small, open, about 1 mm deep; dissepimentarium regular, 0.5 to 1.0 mm wide; dissepiments concentric or pseudoherringbone; false wall stereozone present; axial structure clisiophylloid, elongate, with only 1 or 2 septal lamellae; medial plate well developed, nearly straight, as much as 4 mm long, connected in some corallites to counter septum; axial tabellae number about 2 or 3 ranks on each side of medial plate, rather symmetrically developed; corallite wall 0.1 to 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium narrow, of 1 to 3 (rare) ranks of small, steeply dipping dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae of 1 to 3 ranks, elongate, steeply inclined inwards and upwards to medial plate; periaxial tabellae generally of 1 or 2 ranks, horizontal or gently inclined inwards and upwards to axial tabellae.

Documentation. UCMP holotype 37204. Five thin sections and 43 polished sections from one corallum from UCMP locality D-828 were studied.

Discussion. This corallum is stratigraphically the highest colonial rugose coral found in the McCloud Bridge section. It has been so highly altered that many of the corallites are not preserved in detail, and most of the limestone matrix has been altered to masses of radiating black crystals that color entire beds black like some limestone beds of the Hirz Mountain section. A few corallites are well enough preserved to observe the structure.

The simplicity of the axial structure, the protrusion of the minor septa into the tabularium as spines, the size, and the number of septa readily distinguish *H. hammani* from other species, except *H. merriami* n. sp. and *H. wexoi* n. sp. *H. hammani* is differentiated in the discussions following the descriptions of these.

Etymology. The species is named for Mr. Howard Hamman.

Heritschioides merriami n. sp.

Figures 23a–c

Diagnosis. A species of *Heritschioides* characterized by the combination of moderately large corallites, a moderately complex and symmetrical axial structure, relatively few major septa, long minor septa, and relatively straight major septal ends. It has larger corallites and a more complex axial structure than *H. hammani*. It has straighter septal ends and a somewhat more symmetrical and complex axial structure than *H. wexoi*.

External Description. Corallum phaceloid, hemispheroidal, maximum observed height 20 cm, width 11 cm; corallites parallel, closely spaced, many touching; epitheca poorly preserved, showing some transverse wrinklings; calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 13 to 15 mm, very closely spaced; septa of 2 orders, 22 to 23 each, straight to somewhat sinuous, thin in dissepimentarium (about 0.1 mm wide), dilate in tabularium (about 0.2 mm at base), thinning axially; major septa 3.5 to 6 mm long, touching or slightly withdrawn from axial structure, except cardinal septum 2.5 to 3 mm long; minor septa well developed, 2 to 3.5 mm long, crossing dissepimentarium and entering tabularium as much as 0.5 mm; fossula small, open, about 1 mm deep; dissepimentarium regular, dissepiments angulo-concentric, straight, pseudoherringbone; thin stereozone formed on some dissepiments at tabularium interface; axial structure clisiophylloid, symmetrical, occupying most of tabularium beyond major septa, elliptical to circular, dimensions 3.5 by 3.5 mm, 2 by 3 mm, 2.5 by 4 mm; medial plate well developed, straight to somewhat sinuous, thin to slightly dilate, length 2.0 to 2.5 mm; septal lamellae number 8 to 14, generally straight to somewhat sinuous, rather regularly developed, many opposite one another on each side of medial plate; corallite wall about 0.1 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 6 steeply dipping ranks of large and small cystose dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae small, cystose, dipping inwards and upwards to medial plate; periaxial tabellae number about 17 in 1 vertical cm, highly varied in inclination, flat, gently domed, generally dipping inwards and upwards to axial tabellae, generally of 1 rank.

Documentation. LACMIP holotype 6389. Three thin sections and 15 polished sections from one corallum from LACMIP locality 1120 were studied.

Discussion. *H. merriami* has corallite diameters generally greater than 10 mm, a maximum number of major septa fewer than 25, minor septa that extend into the tabularium, and a symmetrical axial structure. As can be seen from Figure 17, it therefore is comparable only with *H. hammani* and *H. wexoi*. *H. hammani* has a much smaller corallite diameter (10 to 12 mm) and a much simpler axial structure than *H. merriami*. It is distinguished from H. *wexoi* in the discussion after that species description.

Etymology. The species is named for Dr. Charles W. Merriam.

Heritschioides rowetti n. sp.

Figures 23d, 24a–c

Diagnosis. A species of *Heritschioides* characterized by the combination of relatively small corallites, relatively few septa, long minor septa, and a symmetrical axial structure. It has smaller corallites and fewer septa than *H. columbicum*, *H. coogani*, *H. durhami*, *H. washburni*, *H. wildei*, and *H. woodi*.

External Description. Corallum phaceloid, large, exact shape not seen, maximum size of largest fragment 33 cm long, 5 cm wide; corallites closely spaced or touching in some coralla, as much as 2 cm apart in others; epitheca with low, rounded, transverse growth wrinklings, irregularly spaced 1 to 3 mm apart; calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 9 to 13 mm, touching to as much as 7 mm apart; septa of 2 orders, 17 to 24 each, generally somewhat dilate in tabularium, straight to slightly sinuous; major septa 3 to 5.5 mm long, except cardinal septum 2.4 to 3.2 mm long, generally very close to or touching axial structure, rare counter septa connected with medial plate; minor septa well developed, 1 to 1.5 mm long, crossing dissepimentarium and generally extending into tabularium as dilate spines; fossula small, open, about 2 mm deep; dissepimentarium regular, 1.3 to 2.1 mm wide; dissepiments concentric or herringbone (very rarely lonsdaleoid); false wall stereozone present; axial structure clisiophylloid, circular to elongate, generally symmetrical appearing, with 4 to 11 septal lamellae; medial plate generally well developed, slightly dilate (rarely thin), straight to somewhat sinuous, 2 to 4 mm long, connected in some corallites to counter septum; axial tabellae in 2 to 4 ranks on each side of medial plate, outer rank dilate in some corallites; corallite wall 0.1 to 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium moderately wide, of 1 to 3 ranks of mixed small and large, steeply dipping dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae of 2 to 5 ranks, elongate, steeply inclined inwards and upwards to medial plate, not uniform in size; periaxial tabellae generally of 1 or 2 ranks, horizontal or gently inclined inwards and upwards to axial tabellae or sagging or gently inclined outwards and upwards to dissepimentarium.

Documentation. LACMIP holotype 6390, LACMIP paratypes 6391–6399. Four thin sections and 57 polished sections from ten coralla from LACMIP locality 1125 were studied.

Discussion. *H. rowetti* superficially resembles *H. parvum* Stevens, 1967, and *H. buttensis* Stevens, 1967, both from the Leonardian Arcturus Formation of White Pine County, Nevada. It differs from the former species by having longer minor septa and from the latter species by having a narrower dissepimen-

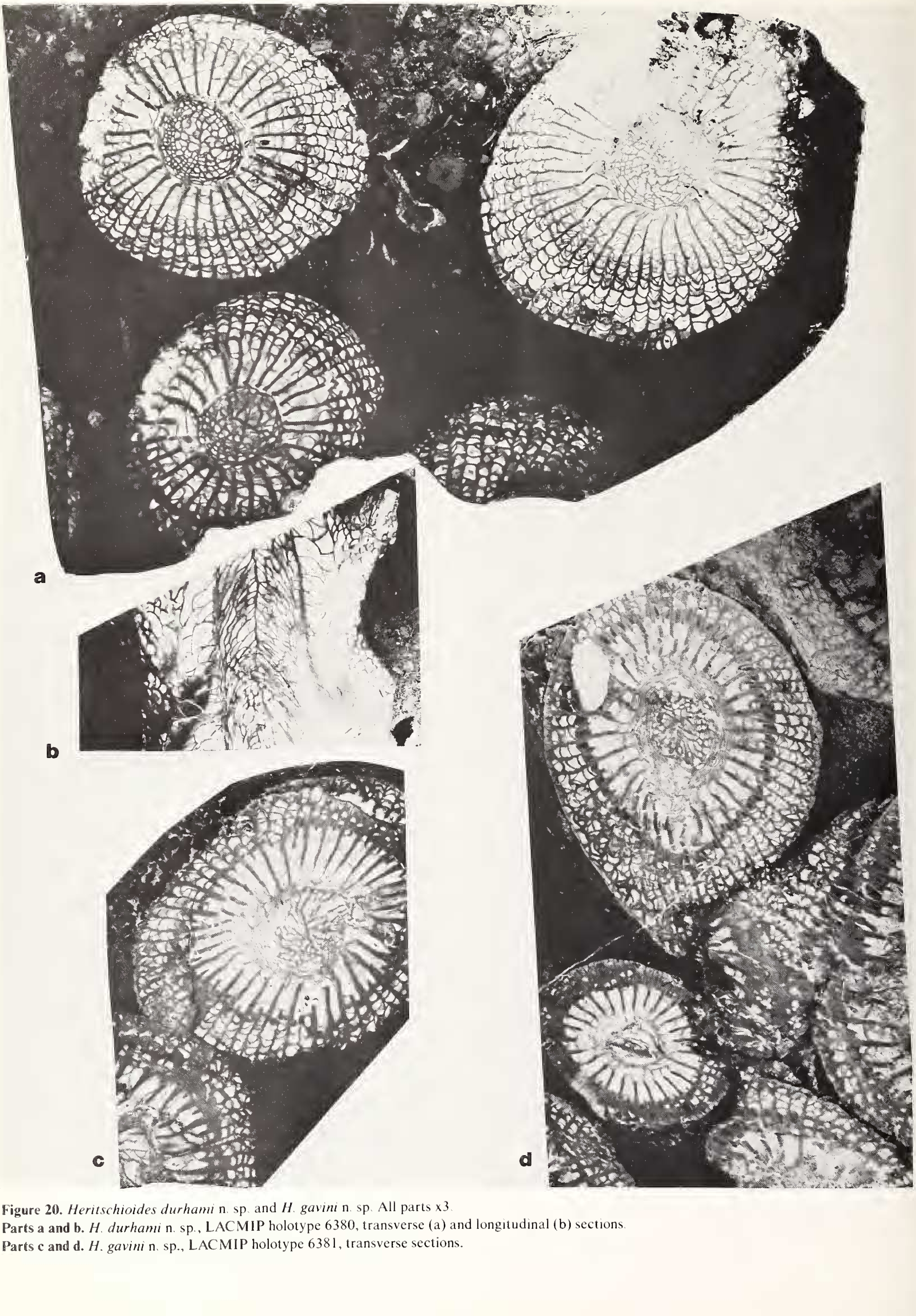


Figure 20. *Heritschioides durhami* n. sp. and *H. gavini* n. sp. All parts x3.

Parts a and b. *H. durhami* n. sp., LACMIP holotype 6380, transverse (a) and longitudinal (b) sections.

Parts c and d. *H. gavini* n. sp., LACMIP holotype 6381, transverse sections.

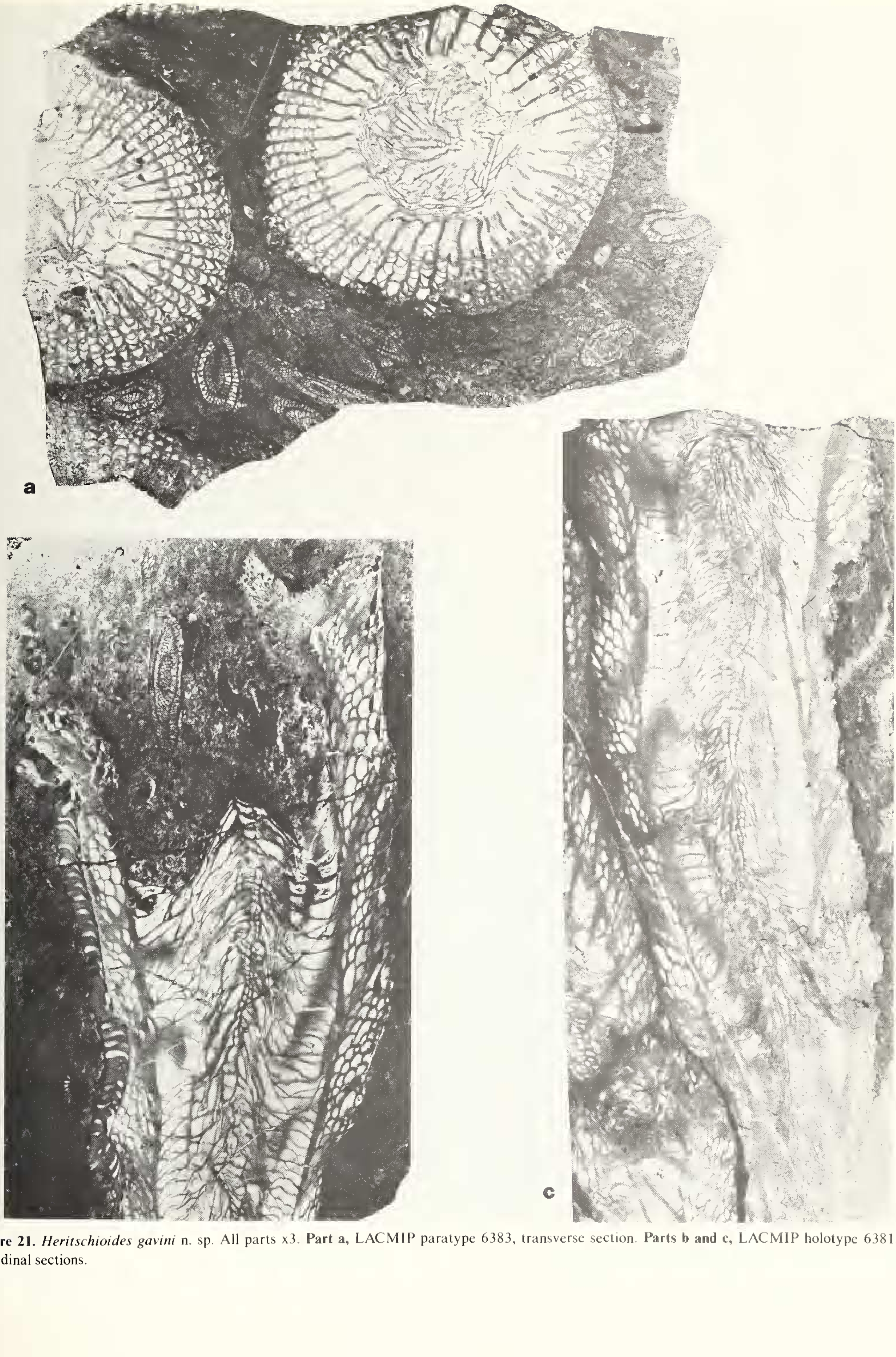


Figure 21. *Heritschioides gavini* n. sp. All parts x3. **Part a,** LACMIP paratype 6383, transverse section. **Parts b and c,** LACMIP holotype 6381, longitudinal sections.

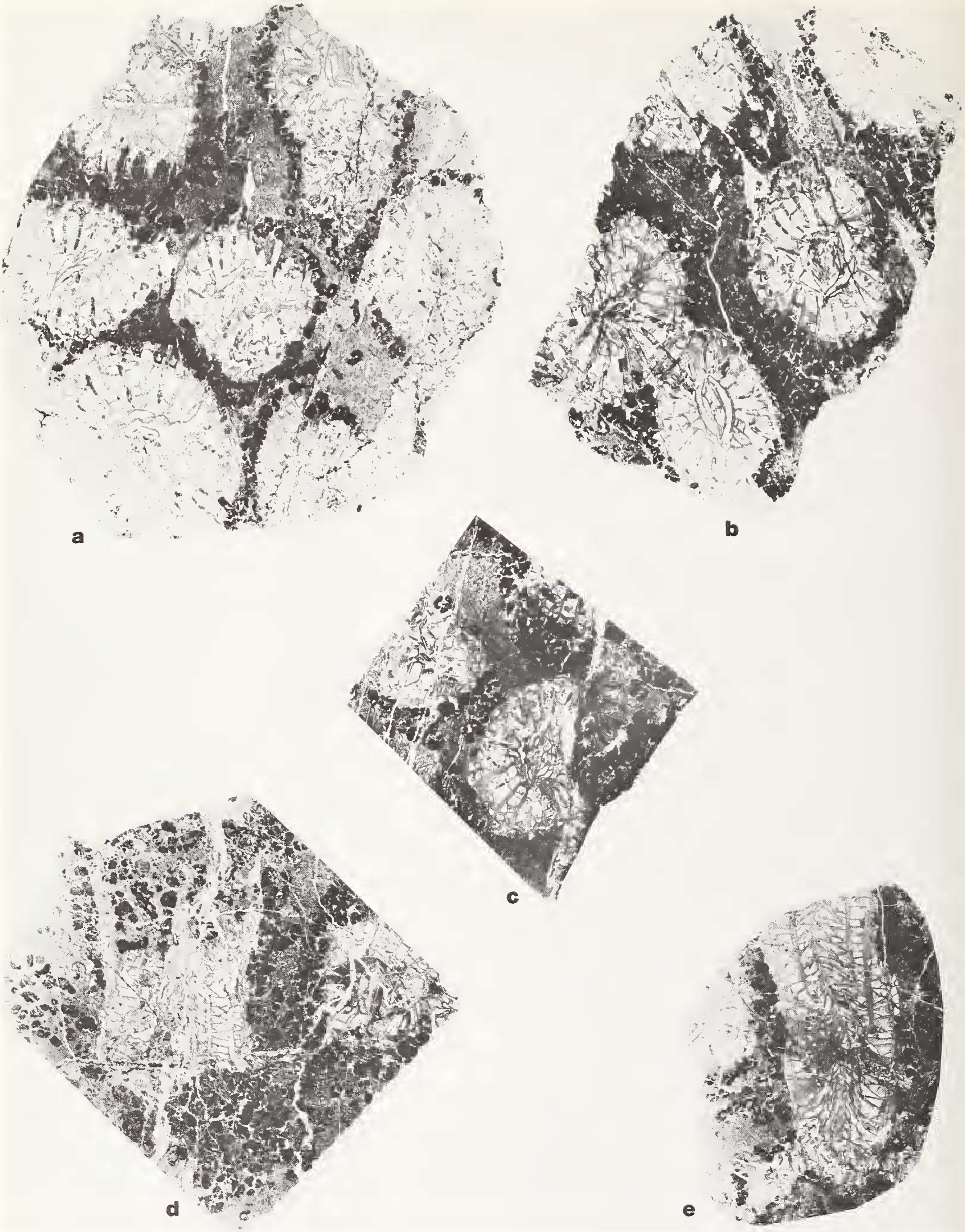


Figure 22. *Heritschioides hammani* n. sp., UCMP holotype 37204, transverse sections (a–c) and transverse and longitudinal sections (d, e). All parts x3.

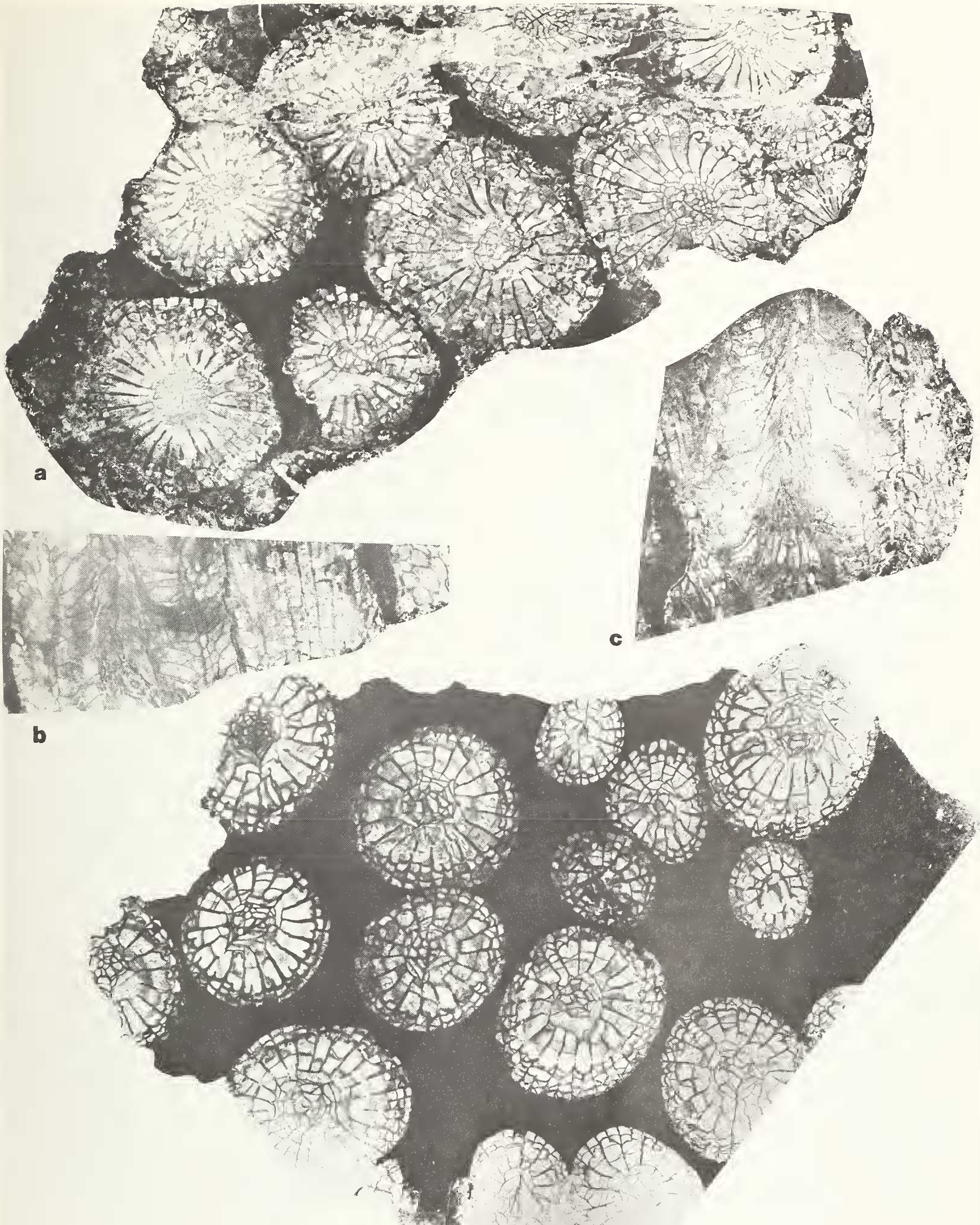


Figure 23. *Heritschioides merriami* n. sp. and *H. rowetti* n. sp. All parts x3.
Parts a through c. *H. merriami* n. sp., LACMIP holotype 6389, transverse (a) and longitudinal (b, c) sections.
Part d. *H. rowetti* n. sp., LACMIP paratype 6391, transverse section.

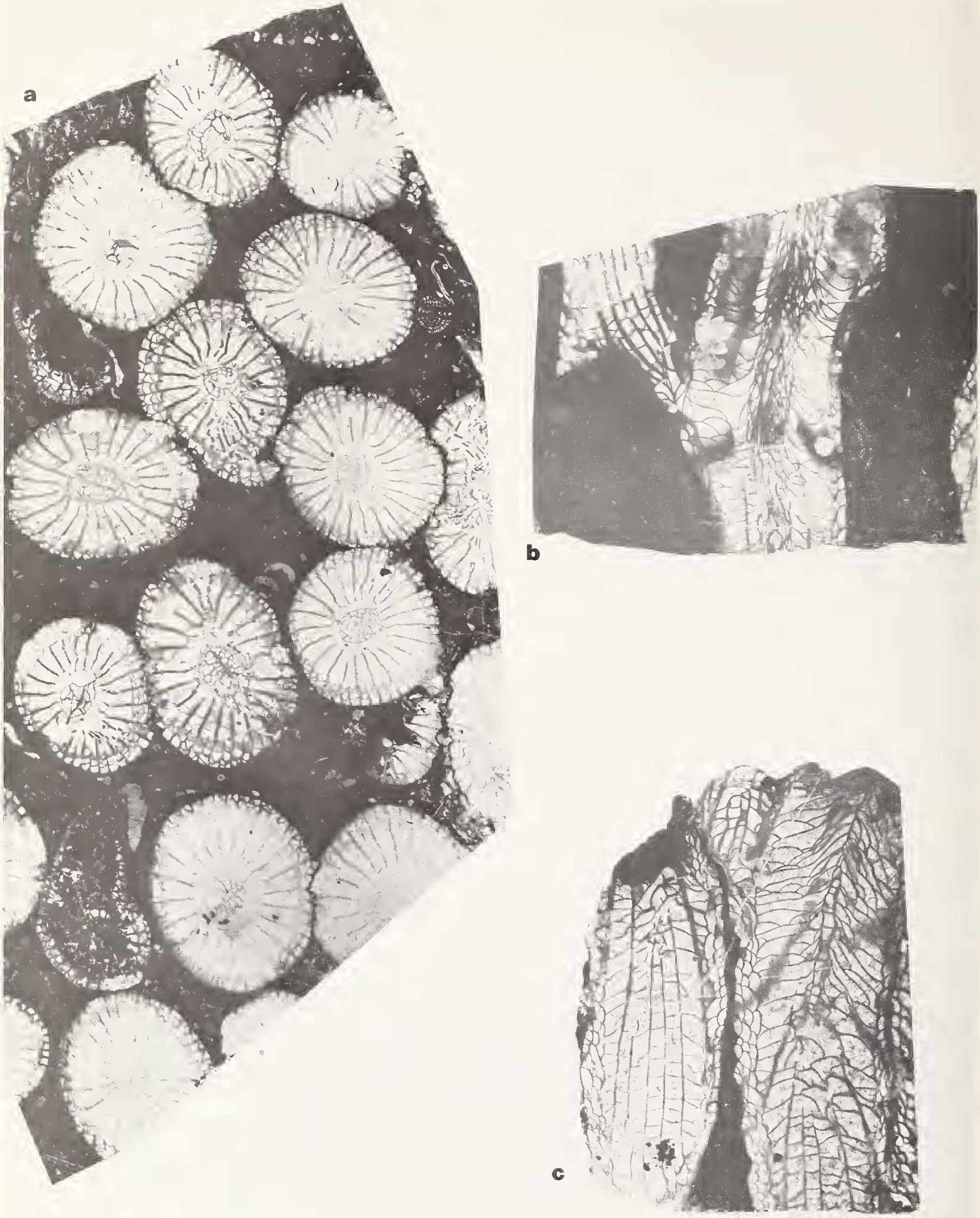


Figure 24. *Heritschioides rowetti* n. sp. All parts x3. **Parts a and b,** LACMIP holotype 6390, transverse (a) and longitudinal (b) sections. **Part c,** LACMIP paratype 6391, longitudinal section.

tarium, a smaller axial structure with less sinuous axial lamellae, and a better defined axial plate. There is, however, considerable variation in the corallites of *H. rowetti* in every corallum examined. *H. rowetti* has smaller corallite diameters than other species in its group as shown in Figure 17.

Etymology. The species is named for Dr. Charles L. Rowett.

Heritschioides skinneri n. sp.

Figures 25a–c

Diagnosis. A species of *Heritschioides* characterized by the combination of a moderately asymmetrical axial structure with a relatively well-defined medial plate, a relatively narrow dissepimentarium, large corallites, and a large number of relatively short septa. It has a smaller, less complex, and more symmetrical axial structure than *H. hillae.* It has a more symmetrical and a more complex axial structure and a narrower dissepimentarium than *H. ochocoensis.* It has shorter septa and a more symmetrical axial structure with a better defined medial plate than *H. moormanensis.*

External Description. Corallum phaceloid, maximum observed diameter 11 cm; corallites parallel, closely spaced to 3 cm apart; epitheca and calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 1 to 14 mm, touching to as much as 5 mm apart; septa of 2 orders, 26 to 30 each, some dilate in tabularium, straight to slightly sinuous; major septa 3.5 to 6 mm long, except cardinal septum 2.5 to 4.5 mm long, generally close to but slightly withdrawn from axial structure; minor septa thin, 0.5 to 1.5 mm long, generally confined to dissepimentarium, rarely appearing in tabularium as short spines; fossula small, open, about 0.5 mm deep; dissepimentarium regular, 1 to 2 mm wide; dissepiments concentric or pseudoherringbone; false wall stereozone generally not present, rarely slightly developed; axial structure clisiophylloid, large, asymmetrical, with numerous septal lamellae; medial plate variously developed, highly sinuous to nearly straight, slightly dilate to not dilate, 1.5 to 4 mm long; axial tabellae abundant in many corallites, generally asymmetrically developed in spider-web pattern; corallite wall about 0.1 mm wide.

Longitudinal Section Description. Dissepimentarium narrow, of 1 to 3 ranks of steeply dipping, small dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae of 2 to 3 ranks, elongate, steeply inclined inwards and upwards to sinuous medial plate, periaxial tabellae of 1 to 3 ranks, gently inclined inwards and upwards to axial tabellae.

Documentation. UCMP holotype 37205. Three thin sections and 32 polished sections from one corallum from UCMP locality D-804 were studied.

Discussion. *H. skinneri* is similar in superficial appearance to the type species of the genus, *H. columbicum* from British Columbia, Canada. In the latter species, however, the minor septa generally extend into the tabularium, whereas in *H. skinneri* they are generally confined to the dissepimentarium. *H. hilae* Wilson and Langenheim, 1962, has a larger and more asymmetrical axial structure than *H. skinneri. H. ochocoenis* (Merriam, 1942), from the Coyote Butte Formation of Crook County, Oregon, has a simpler axial structure and wider dissepimentarium. *H. moormanenis* Stevens, 1967, from the Arcturus Formation of White Pine County, Nevada, has septa that generally touch the axial structure and a much more asymmetrical axial structure in which the medial plate is so sinuous as to be generally unrecognizable. The other nominal species are not closely comparable.

Etymology. The species is named for Dr. John W. Skinner.

Heritschioides smithi n. sp.

Figures 25d, 26a–c

Diagnosis. A species of *Heritschoides* characterized by the combination of relatively short minor septa, a relatively small and asymmetrical or simple axial structure, relatively small corallites, and relatively few septa. It has shorter minor septa, a smaller axial structure, somewhat smaller corallites, and somewhat fewer septa than *H. gavini.*

External Description. Corallum phaceloid, hemispheroidal, maximum observed diameter 10 cm; corallites parallel to subparallel, very closely spaced or touching; epitheca and calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 15 to 21 mm, touching to as much as 4 mm apart; septa of 2 orders, 26 to 32 each, straight to slightly sinuous, thin in dissepimentarium (0.1 to 0.2 mm wide), dilate in tabularium (0.2 to 0.3 mm wide); major septa 6.5 to 7.5 mm long, except shortened cardinal septum 4.5 to 5 mm long; minor septa well developed, 3 to 4 mm long, generally extending across dissepimentarium into tabularium as spines, fossula small, open; dissepimentarium regular, wide; dissepiments, pseudoherringbone, straight, concentric, or angulo-concentric; false wall stereozone present; axial structure clisiophylloid, variable, simple or asymmetrical where more complex (about 2.5 by 3.5 mm in latter); medial plate slightly dilate (0.1 mm), 3 to 4 mm long, sinuous, connected in some corallites to counter septum; septal lamellae irregularly developed, generally short, 2 to 6 per corallite, not touching septa; corallite wall aboout 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium 2.5 to 4 mm wide, composed of 2 to 6 ranks of steeply dipping, small and cystose or large and elongate dissepiments; tabellae of 2 poorly differentiated zones: axial and periaxial; axial tabellae tent-shaped, in 1 to 3 ranks; periaxial tabellae horizontal or gently sloping inwards and upwards to axial tabellae (rarely sloping inwards and down), in 1 to 2 ranks, 15 to 20 tabellae per cm.

Documentation. UCMP holotype 37206, LACMIP paratype 6400. Six thin sections and 46 polished sections from the holotype corallum from UCMP locality D-840 and two thin sections and 24 polished sections from the paratype corallum from LACMIP locality 1124 were studied.

Discussion. The only other species of *Heritschioides* with large corallites (more than 10 mm diameter), a large number of major septa (more than 25), minor septa that generally extend into the tabularium, and an asymmetrical (some corallites) axial structure is the type species, *H. columbicum* from British Columbia. *H. columbicum*, however, has a large, well-defined axial structure with numerous septal lamellae and axial tabellae. *H. smithi* has a curiously deformed looking axial structure that is composed in many corrallites of simply a twisted medial plate with a few, very short, asymmetrically placed septal lamellae in the simplest forms. Some corallites of *H. smithi* develop a somewhat more

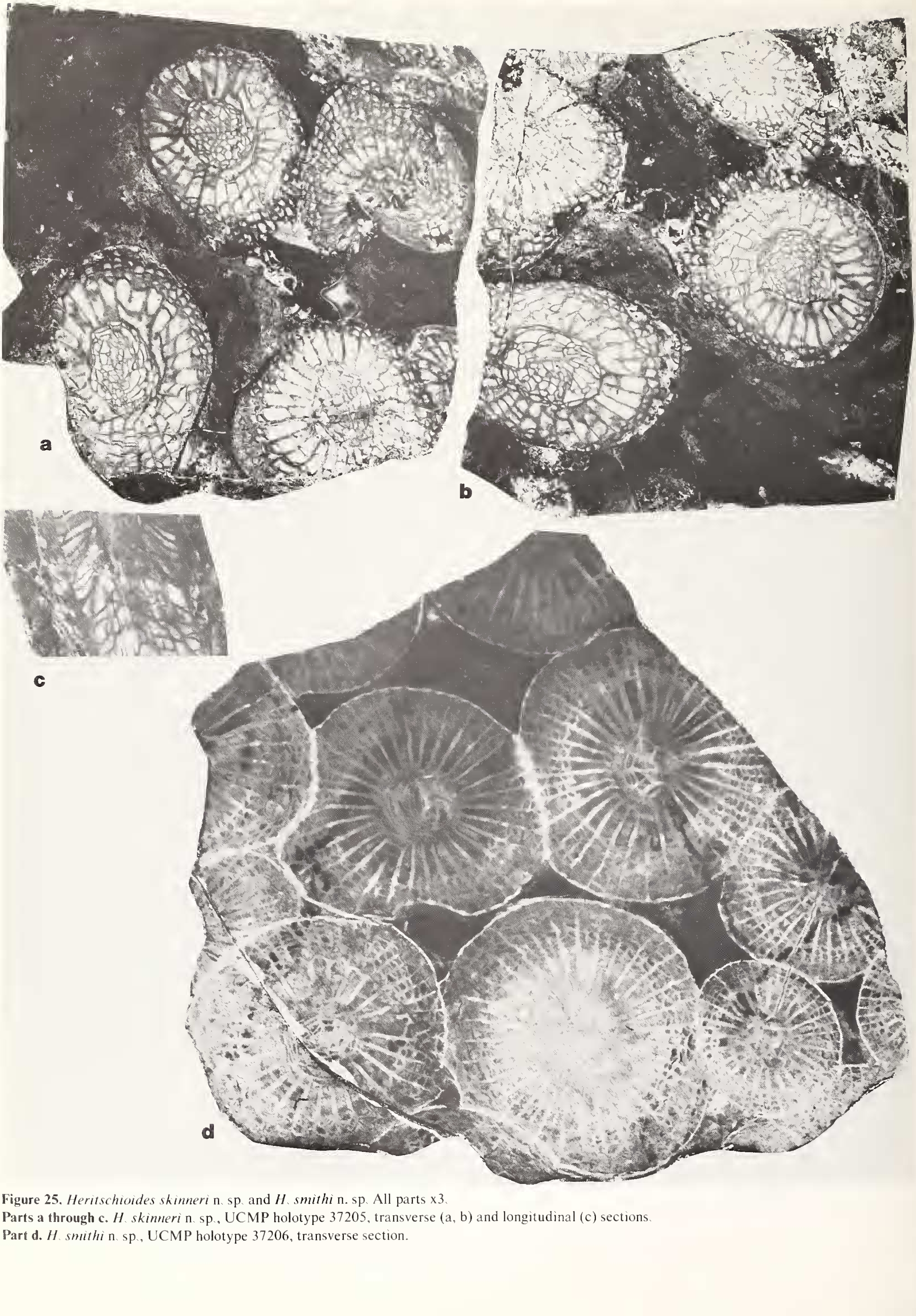


Figure 25. *Heritschioides skinneri* n. sp. and *H. smithi* n. sp. All parts x3.

Parts a through c. *H. skinneri* n. sp., UCMP holotype 37205, transverse (a, b) and longitudinal (c) sections.
Part d. *H. smithi* n. sp., UCMP holotype 37206, transverse section.

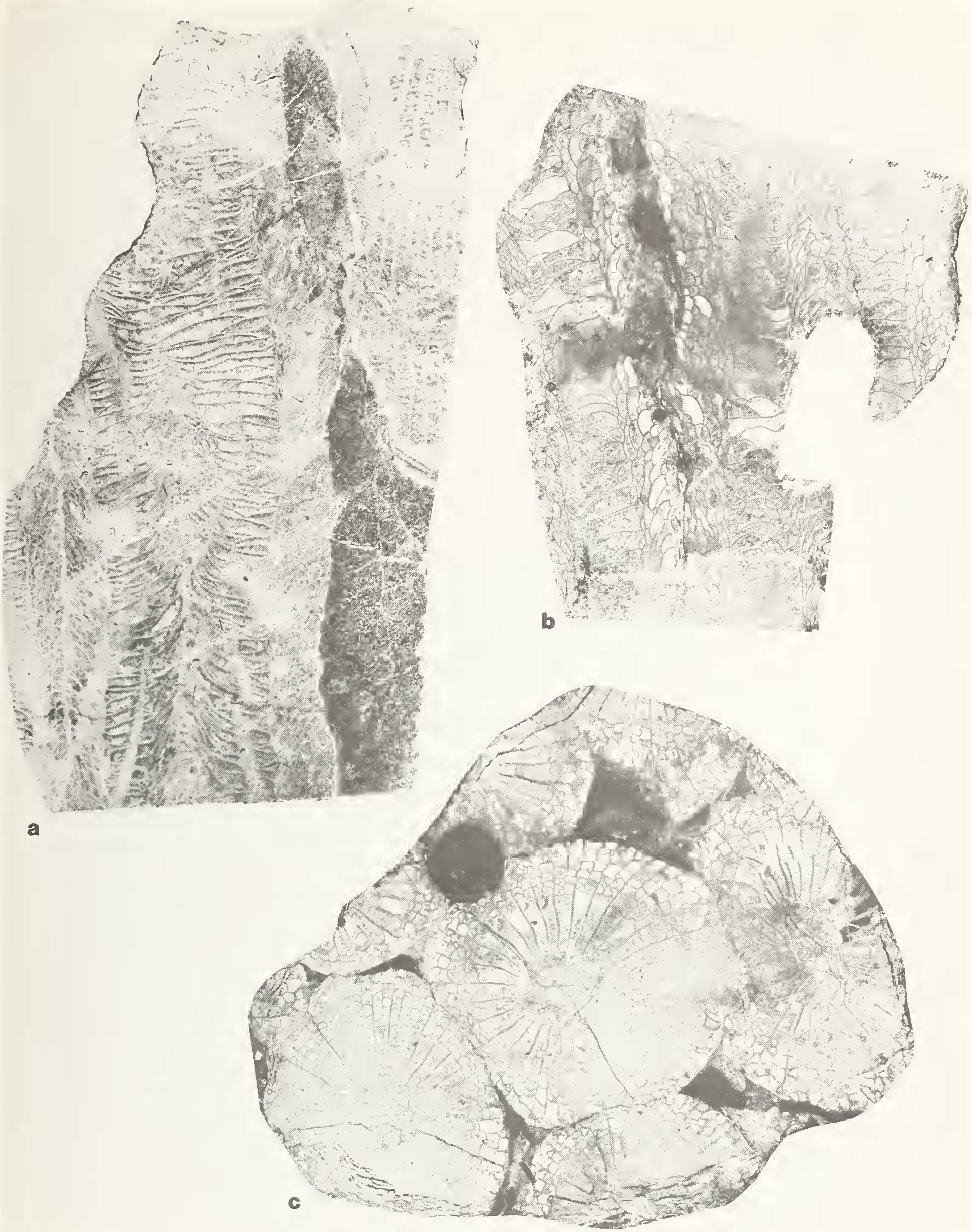


Figure 26. *Heritschioides smithi* n. sp. All figures x3. **Part a,** UCMP holotype 37206, longitudinal section. **Parts b and c,** LACMIP paratype 6400, longitudinal (b) and transverse (c) sections.

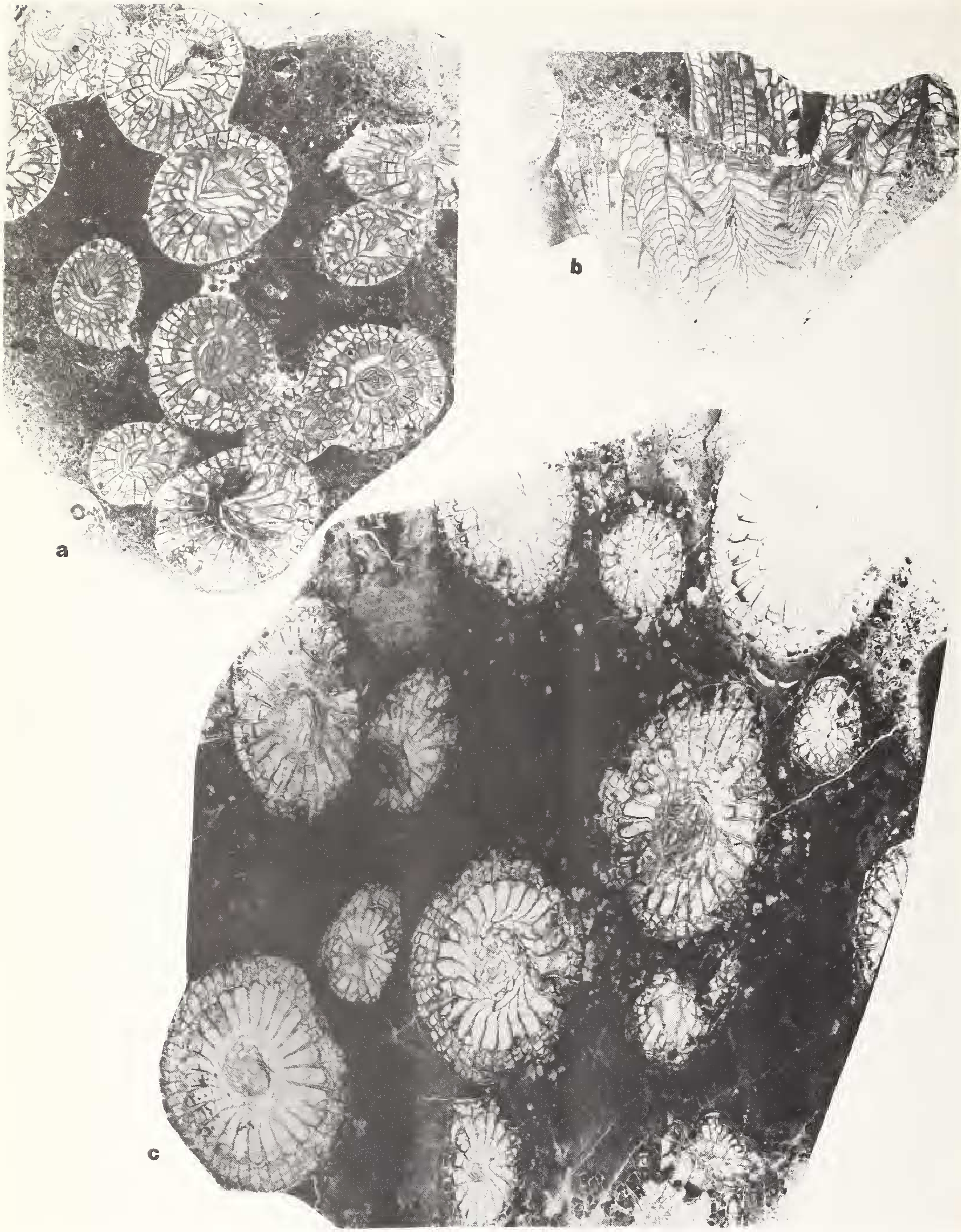


Figure 27. *Heritschioides stevensi* n. sp. and *H. wexoi* n. sp. All parts x3.
Parts a and b. *H. stevensi* n. sp., UCMP holotype 37207, transverse (a) and longitudinal (b) sections.
Part c. *H. wexoi* n. sp., LACMIP holotype 6401, transverse section.

complex axial structure with longer septal lamellae joined by a few axial tabellae, but these are much more asymmetrical than the axial structure of *H. columbicum*. *H. smithi*'s differences with *H. gavini* are discussed following the description of that species. The holotype corallum is somewhat recystallized, and the structures are more apparent when studied in polished than in thin section. This has made them difficult to photograph satisfactorily, but the paratype slides photograph better.

Etymology. The species is named for D. Stanley Smith.

Heritschioides stevensi n. sp.

Figures 27a–b

Diagnosis. A species of *Heritschioides* characterized by the combination of small corallites, short minor septa, a small number of major septa, a relatively small and simple axial structure, and a relatively narrow dissepimentarium. It has a smaller and simpler axial structure and a somewhat narrower dissepimentarium than *H. parvum*.

External Description. Corallum phaceloid, hemispheroidal, maximum observed diameter 20 cm; epitheca and calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 8 to 11 mm, touching or as much as 15 mm apart; septa of 2 orders, 18 to 22 each, straight or slightly sinuous, thin throughout; major septa 2.0 to 3.5 mm long, except cardinal septum 2.3 to 3.0 mm long, withdrawn from axial structure except counter in some corallites continuous with medial plate; minor septa short, 0.5 to 1.0 mm long, absent in parts of some corallites, generally confined to tabularium; fossula small; dissepimentarium regular, 0.5 to 1.9 mm wide; dissepiments concentric, angulo-concentric, herringbone, or pseudoherringbone; axial structure clisiophylloid, asymmetrical, very simple, elongate, 1.5 to 2.5 mm long, about 1.0 mm wide, composed of medial plate, septal lamellae, and axial tabellae; medial plate thin, straight to somewhat sinuous, attached to counter septum in some corallites; septal lamellae short, irregularly developed, 1 to 4 in number, corallite wall about 0.1 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 4 ranks of dissepiments, various sizes and various inclinations; elongate dissepiments generally gently inclined, small cystose dissepiments generally steeply inclined; tabellae of 2 poorly defined ranks, axial and periaxial; axial tabellae of 1 to 2 ranks, steeply inclined inwards and upwards to medial plate; periaxial tabellae striaght to slightly doomed, more gently inclined inwards and upwards to periaxial tabellae.

Documentaiton. UCMP holotype 37207. Two thin sections and 34 polished sections from one large corallum from UCMP locality D-862 were studied.

Discussion. Only one other species, *H. parvum* Stevens, 1976, from the Arcturus Formation of White Pine County, Nevada, is comparable to *H. stevensi* in corallite diameter, numbers of septa, length of minor septa, and simplicity of the axial structure. *H. parvum* may be distinguished readily because it has dilate major septa in the tabularium, a more complex axial structure where it is most highly developed (more axial tabellae), and minor septa better developed and more consistently present throughout the corallites, a few of which even extend into the tabularium.

Etymology. The species is named for Dr. Calvin H. Stevens.

Heritschioides wexoi n. sp.

Figures 27c, 28a–e

Diagnosis. A species of *Heritschioides* characterized by the combination of a large number of septa, long minor septa, moderatley large corallites, a moderately complex axial structure, and axial ends of many septa twisted in vortex fashion. It has larger corallites and a more complex axial structure than *H. hammani*. It has more twisted septal ends and a somewhat less symmetrical and less complex axial structure than *H. merriami*.

External Description. Corallum phaceloid, maximum diameter observed 151 cm, height 46 cm; corallites parallel to subparallel, closely spaced; epitheca with faint rugae; calyx with axial boss, not well preserved.

Transverse Section Description. Corallites circular, diameter 10 to 16 mm, touching or as much as 6 mm apart; septa of 2 orders, 18 to 25 each, dilate in tabularium, major septa 3.5 to 4.5 mm long, except cardinal septum about 3 to 3.5 mm long (some cardinal septa not shortened), straight to sinuous, axial ends attenuate in many, twisted in axial vortex fashion to axial structure, withdrawn and not curved in others; minor septa well developed, 1.25 to 2 mm long, generally crossing dissepimentarium, many extending into tabularium as dilate spines 0.25 to 0.5 mm long; fossula small, open, inconspicuous or absent in some; dissepimentarium regular, 1 to 1.5 mm wide, rarely to 3 mm wide; dissepiments concentric, angulo-concentric, or pseudoherringbone; false wall stereozone present; axial strucutre clisiophylloid, highly varialbe, ranging from medial plate with 1 or 2 septal lamellae to complex symmetrical or asymmetrical form, attached to major septa in some, unattached in others; medial plate generally sinuous, slightly dilate, 1 to 3.5 mm long; axial tabellae in to 3 ranks on each side of medial plate, variably developed, in some combined with septal tabellae forming "spider web"; corallite wall about 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium moderately wide, of 2 to 5 ranks of small, steeply dipping dissepiments; tabellae of 2 poorly defined zones, axial and periaxial taballae of 3 to 4 ranks, tent-shaped, sloping inwards and upwards to medial plate; periaxial tabellae of 1 to 2 ranks, horizontal (few) or inclined inwards and upwards to axial tabellae.

Documentation. LACMIP holotype 6401, LACMIP paratypes 6402–6411. Eight thin sections and 86 polished sections from 11 coralla from LACMIP locality 5316 were studied.

Discussion. *H. wexoi* resembles only *H. hammani* and *H. merriami*. These types have corallite diameters generally greater than 10 mm, 25 or fewer major septa, and minor septa that generally extend into the tabularium, a combination of characters that distinguishes these from other species of the genus.

H. wexoi has widely variable axial structures, some of which are attached to the twisted axial ends of major sept. *H. merriami* differs in having asymmetrical, complex axial structure and no twisted septal ends. *H. hammani* has smaller corallites (10–12

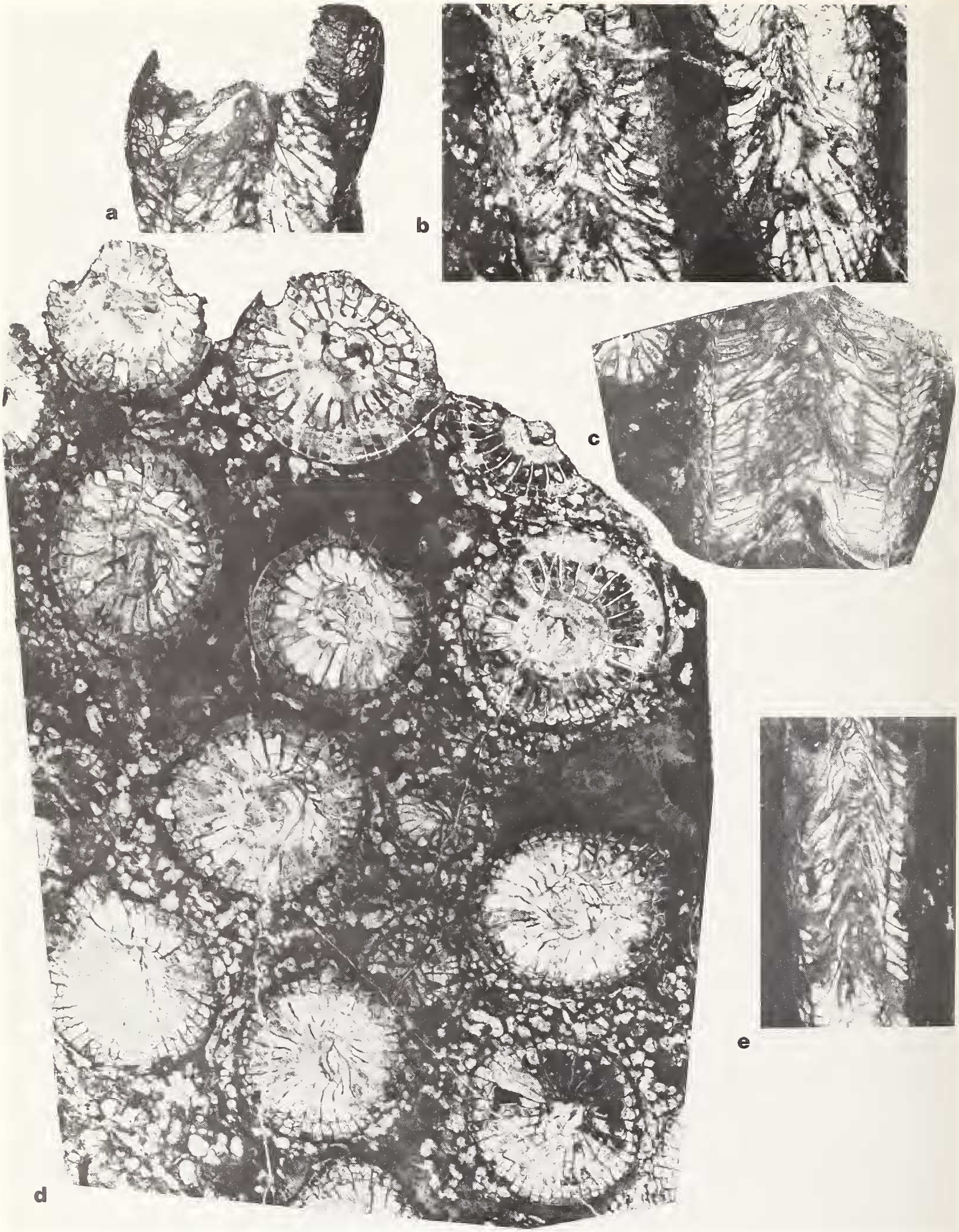


Figure 28. *Heritschioides wexoi* n. sp. All parts x3. **Parts a and c,** LACMIP holotype 6401, longitudinal sections. **Parts b, d, and e,** LACMIP paratype 6402, longitudinal (b, e) and transverse (d) sections.

mm), a simpler axial structure, and lacks the twisted septa of *H. wexoi*.

Etymology. The species is named for Mr. John B. Wexo.

Heritschioides wildei n. sp.

Figures 29a–e

Diagnosis. A species of *Heritschioides* characterized by the combination of large corallites, numerous septa, relatively short and thin minor septa, and a symmetrical axial structure with a well-defined medial plate. It has shorter and somewhat thinner minor septa and a better defined medial plate than *H. columbicum*. It has a broader dissepimentarium and generally more dilate major septa in the tabularium than *H. coogani*. It has generally smaller corallites, a somewhat narrower dissepimentarium, and a more symmetrical axial structure with a better defined medial plate than *H. durhami*. It has larger corallites and more septa than *H. rowetti*. It has fewer septa and a more symmetrical axial structure than *H. washburni*. It has shorter and thinner minor septa, fewer herringbone dissepiments, and a somewhat shorter medial plate than *H. woodi*.

External Description. Corallum phaceloid, hemispheroidal, maximum observed diameter 12 cm; epitheca badly preserved, with some transverse wrinklings; calyx deep with walls sloping nearly vertically inwards to depth of about 1.2 cm; calicular floor crossed by prominent septa; axial boss central, large, inversely conical, diameter about 4 mm, height about 4 mm.

Transverse Section Description. Corallites circular, diameter 14 to 18 mm, touching to as much as 5 mm apart; septa of 2 orders, 24 to 30 each, straight to somewhat sinuous, thin in dissepimentarium (about 0.1 mm), dilate in tabularium (about 0.2 to 0.3 mm); major septa generally slightly withdrawn from axial structure, 4.5 to 6.9 mm long, except shortened cardinal septa generally 0.5 to 1.0 mm shorter; minor septa well developed, 1.5 to 3.5 mm long, generally extending across dissepimentarium into tabularium about 0.5 mm, dilate in tabularium; fossula small, open, 0.5 to 1.0 mm deep; dissepimentarium regular, 1.5 to 2.5 mm wide; dissepiments herringbone near corallite wall, otherwise concentric, angulo-concentric, or straight; stereozone on row of dissepiments separating dissepimentarium from tabularium thin; axial structure clisiophylloid, large, circular to subcircular, diameter 3.5 to 5.0 mm; medial plate well developed, dilate and nearly straight to thin and rather sinuous, about 1.5 to 4.0 mm long, 0.1 to 0.2 mm wide where dilate; septal lamellae thin, variously developed, 11 to 19, sinuous to straight, unequal number on each side of medial plate; axial tabellae numerous, intercepting septal lamellae at near right angles, straight, curved, or slightly sinuous (rare); corallite wall about 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium wide, of 4 to 10 ranks of rather steeply dipping, various sized dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae of various sizes, cystose, dipping steeply inwards and upwards to medial plate in 5 to 8 ranks on each side; periaxial tabellae generally sloping gently inwards and upwards to axial tabellae in 1 to 4 ranks.

Documentation. UCMP holotype 37208, LACMIP paratypes 6412–6413. Five thin sections and 42 polished sections from three coralla from LACMIP locality 1125 (paratypes) and UCMP locality D-852 (holotype) were studied.

Discussion. *H. wildei* occurs in the same beds as *H. rowetti*, but the latter has much smaller corallites and fewer septa. *H. wildei* is closest to *H. woodi* Wilson and Langenheim, 1962, from the Leonardian Arcturus Formation of White Pine County, Nevada, but the latter species has longer and more dilate minor septa in the tabularium, a dissepimentarium composed of a greater number of herringbone dissepiments, and an axial structure that is generally more symmetrical in appearance with a straighter medial plate. *H. washburni* (Merriam, 1942) from the Permian Coyote Butte Formation of Crook County, Oregon, has a greater number of septa, generally less well-developed minor septa, and a generally less symmetrical axial structure. *H. columbicum* (Smith, 1935), from British Columbia has longer minor septa. *H. coogani* has a narrower dissepimentarium.

Etymology. The species is named for Dr. Garner L. Wilde.

Heritschioides (?) *californiense* Meek, 1864

Figures 5:2b; 15d–e; 33b–d; 33e (?)

Lithostrotion? Californiense Meek, 1864, p. 6, pl. 1, fig. 2b (and (?) 2, 2a, 2c).

External Description. Corallum dendroid (?), maximum observed diameter 22 cm; epitheca apparently smooth except for regularly spaced rugae; calyx deep with walls sloping steeply downwards and inwards to relatively horizontal floor; axial boss prominent, central; septa present in calyx except on axial boss.

Transverse Section Description. Corallites generally circular, diameter 17 to 22 mm, touching or short distances apart; septa of 2 orders, 26 to 34 each, dilate, somewhat thicker in tabularium; major septa 4 to 9 mm long, most somewhat withdrawn from axial structure, few continuous with septal lamellae; minor septa 2 to 4 mm long, extending into tabularium in smaller corallites, confined to dissepimentarium in larger corallites; dissepimentarium regular, as much as 5 mm wide; dissepiments concentric, angulo-concentric, pseudoherringbone, herringbone; false wall stereozone poorly developed; axial structure aulophylloid, very irregular, composed of a loosely arranged group of elements in which the medial plate (if present), septal lamellae, and periaxial tabellae not readily distinguished; corallite wall 0.1 to 0.3 mm wide.

Longitudinal Section Description. Dissepimentarium of 3 to 5 ranks (transverse section shows possible 12) of various size dissepiments (small and cystose to large and highly elongate), steeply dipping; tabellae of 2 rather irregular zones; axial tabellae slope inwards and upwards to septal lamellae (and medial plate?), apparently more steeply inclined in smaller corallites; periaxial tabellae horizontal or sloping gently inwards and upwards (rarely the reverse) to axial tabellae.

Documentation. Three thin sections, one clearly showing a mother and daughter corallite, were prepared and studied from the corallum in the MCZ collection numbered 13. This corallum was figured by Meek (1864, pl. 1, fig. 2b) and is here designated the lectotype. A label glued to the block reading "No. 13

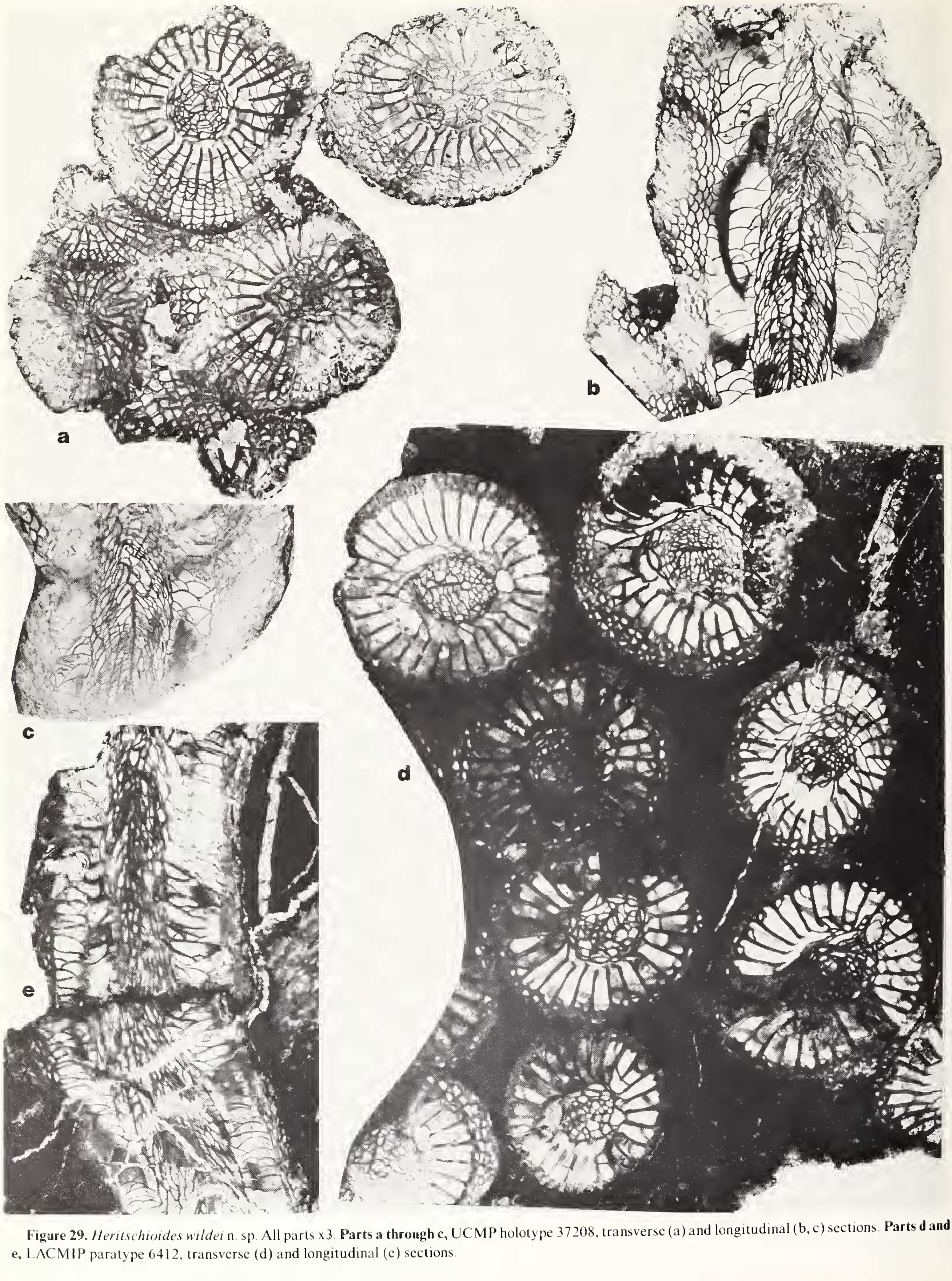


Figure 29. *Heritschioides wildei* n. sp. All parts x3. **Parts a through c,** UCMP holotype 37208, transverse (a) and longitudinal (b, c) sections. **Parts d and e,** LACMIP paratype 6412, transverse (d) and longitudinal (e) sections.

Lithostrotion Californiense, Meek" presumably is written in Meek's hand. A dozen or so other corallites on this block may be the same taxon but were not sectioned.

The type specimens presumably were collected in the McCloud Limestone somewhere south of the Pit River. The absence of *Pseudoschwagerina robusta* in the exposed matrix suggests that they came from higher in the section than the basal 50 feet, where this fusulinid is very abundant. The corals therefore were collected from either fusulinid zones E or F.

Discussion. A transverse section of one corallite in the type corallum suggests the presence of both cardinal and counter open tabular fossulae, but these may be the results of folds in the axial ends of the mesenterics that caused septa to be formed that were doubled back on themselves at the tips. A transverse section of another corallite in the same corallum suggests the presence of an open tabular cardinal fossula. A small transverse section of a single corallite (Fig. 33e) from 210 feet above the base of the Potter Ridge section (UCMP loc. D-836) is very similar in many respects to this species and does have an open tabular fossula and other features questionably like those of *Heritschioides.* I did not collect specimens of this species from the Bayha section (presumably the type area) and, until additional coralla are available, the generic assignment is problematic.

This species is unlike any other nominal species that I have examined.

Genus *Mccloudius* n. gen.

Diagnosis. *Mccloudius* is a phaceloid coral with two orders of septa, a fossula formed by a shortened cardinal septum, a clisiophylloid axial structure, a well-developed regular dissepimentarium that becomes peripherally lonsdaleoid in late ephebic stage, and tabellae of two ranks, both of which slope inwards and upwards.

Type Species. *McCloudius fluvius* n. sp.

Description. As for the type and only known species.

Discussion. *Mccloudius* somewhat resembles *Lonsdaleia* M'Coy, 1849, but the latter has an almost wholly lonsdaleoid dissepimentarium, no fossula, and is a Lower and Middle Carboniferous genus. *Lonsdaleoides* Heritsch, 1936, was reported originally from the Lower Permian of the Carnic Alps and subsequently from the Upper Pennsylvanian or Lower Permian of Japan and Spain. Its peripheral, sporadically developed series of lonsdaleoid dissepiments is similar to that of *Mccloudius,* but *Lonsdaleoides* has no fossula and its axial structure is much thickened and unlike that of *Mccloudius.* The lonsdaleoid dissepimentarium of *Mccloudius* distinguishes it from *Heritschioides* Yabe, 1950, which has a regular dissepimentarium. Other genera are not closely comparable to *Mccloudius.*

Etymology. The genus is named for the McCloud River.

Mccloudius fluvius n. sp.

Figures 30a–f

Diagnosis. Because the genus *Mccloudius* is erected as monotypic, the diagnoses of the genus and of the type species are identical.

External Description. Corallum phaceloid; size, corallite spacing, epitheca, calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameters 13 to 20 mm, not closely spaced, some touching, others as much as 10 mm apart; septa of 2 orders, 25 to 33 each, straight to slightly sinuous, generally thin in dissepimentarium (about 0.7 mm wide), dilate in tabularium (about 0.3 at base) becoming attenuate axially; major septa generally withdrawn from axial structure (few touching), 4 to 6 mm long, except shortened cardinal septum 3 to 3.5 mm long, extending into tabularium 3 to 4 mm; minor septa well developed in most corallites, poorly in some, generally entering tabularium as spines 0.5 to 1.0 mm long, where present in dissepimentarium, total lengths are 1.5 to 3 mm; fossula small, open, formed by shortened cardinal septum, possible depressed tabellae; dissepimentarium variable with ontogeny: (1) regular in most corallites with diameters less than 14 to 16 mm, dissepiments herringbone, pseudoherringbone, straight, concentric, angulo-concentric, (2) lonsdaleoid peripherally in corallites with diameters from about 15 to 20 mm, width 1.5 to 3.8 mm, not lonsdaleoid at thinnest widths, peripheral 2 to 3 mm lonsdaleoid at 2.5- to 3.8-mm widths, axial 0.2 to 1.2 mm regular; lonsdaleoid dissepiments axially convex, variable sized, 2 to 6 rows, not naotic; stereozone separating tabularium from dissepimentarium in larger, some smaller, corallites; axial structure clisiophylloid, variable, subcircular, diameter 2 to 6.5 mm, complex, symmetrical to asymmetrical; medial plate 1 to 3 mm long, straight to sinuous, combined with 5 to 12 septal lamellae (some spines in larger corallites), numerous tabellae; corallite wall 0.2 to 0.4 mm thick, with pronounced V-shaped insertions for septal bases except where lonsdaleoid.

Longitudinal Section Description. Dissepimentarium of 1 to 10 rows (5 to 10 in larger corallites) steeply dipping ranks of dissepiments varying in shape from small and cystose to large and elongate; tabellae of 2 zones, axial and periaxial; axial tabellae elongate, dipping inwards and upwards to medial plate, 4 to 5 ranks; periaxial tabellae various developed, 10 to 15 per cm, 1 to 3 ranks sloping inwards and upwards to axial tabellae.

Documentation. LACMIP holotype 6414, LACMIP paratype 6415, UCMP paratype 37209. Eight thin sections and 39 polished sections from three coralla from LACMIP locality 1114 (holotype 6414, paratype 6415) and UCMP locality D-836 (paratype 37209) were studied.

Discussion. The lower beds of the McCloud Limestone on Potter Ridge have abundant fasciculate corals, but they generally are highly metamorphosed by the massive intrusion at the base, which also intrudes the lower beds in many places. It was not possible to determine if *Mccloudius fluvius* is present in the beds below the type locality. Unfortunately also, even though the corallites clearly branch, it was not possible to determine the precise size or nature of the coralla because many of them were broken before burial. However, they clearly are fasciculate.

There is no other species known to me with which this coral can be compared.

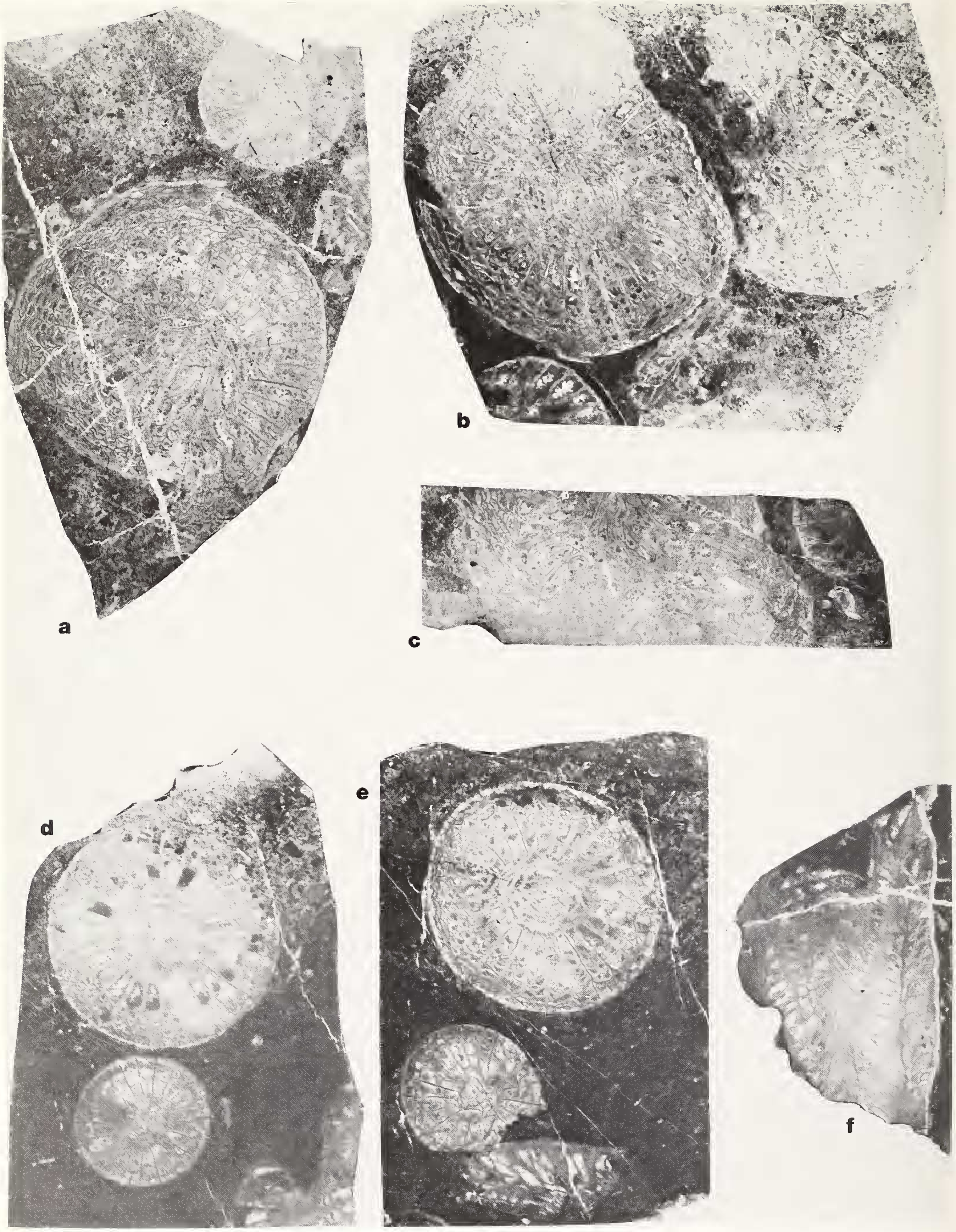


Figure 30. *Mccloudius fluvius* n. gen., n. sp. All parts x3. **Parts a through c,** LACMIP holotype 6414, transverse (a, b) and longitudinal (c) sections. **Parts d and e,** LACMIP paratype 6415, serial transverse sections. **Part f,** UCMP paratype 37209, longitudinal section.

Etymology. *Fluvius*, the species name, is Latin and means river.

Genus *Siphonodendron* M'Coy, 1849

Siphonodendron hongi n. sp.

Figures 31a–b

Diagnosis. A species of *Siphonodendron* characterized by the combination of large corallites, relatively few major septa, very rare dissepiments, and a columella attached to one septum. It has larger corallites, fewer major septa, far fewer dissepiments, and a columella attached to fewer septa than *S. pauciradialis*.

External Description. Corallum phaceloid, external shape not observed, maximum fragmentary diameter 4.5 cm; corallites cylindrical to subcylindrical, parallel, touching to as much as 4 mm apart, many elongated laterally to remain in contact with neighboring corallite; calyx, epitheca not observed.

Transverse Section Description. Corallites circular to subcircular, 5.5 to 7 mm wide, touching to 4 mm apart (generally closer), some attached to nearby corallites by extensions of wall about 5 mm long, 7 mm wide (no internal connections between corallites); septa of 2 orders, 14 to 17 each, straight to somewhat curved, thin; major septa 1 to 2 mm long, thin, withdrawn from columella except 1 (counter?) attached; minor septa rudimentary spines, 0.2 to 0.5 mm long; dissepimentarium absent or present as 1 row; axial structure a columella, simple, elongate, from 0.8 mm long by 0.3 mm wide to 1.1 mm long by 0.6 mm wide, attached to 1 septum (counter); corallite wall 0.1 to 0.3 mm wide.

Longitudinal Section Description. Columella central; tabulae flat, gently sagging, or gently inflated, inclined inwards and upwards to columella, outer ends straight, rarely slightly downturned, 19 per cm; tabellae absent.

Documentation. UCMP holotype 37210. Two thin sections and 27 polished sections from one corallum from UCMP locality B-4837 were studied.

Discussion. *Lithodendron pauciradialis* M'Coy, 1844, the type species for *Siphonodendron*, from the Lower Carboniferous (Mississippian) of Ireland (the type locality), also has been reported from England, Scotland, Russia, and China (Hill, 1940:170). Hill (1940:165) synonymized *Siphonodendron* with *Lithostrotion* Fleming, 1828, which has a cerioid type species. I prefer to use *Siphonodendron* rather than to call this species a "fasciculate *Lithostrotion*."

The type species of *Siphonodendron* has corallites 4 to 5.5 mm in diameter, 18 to 22 major septa, a dissepimentarium, and a columella attached generally to both the counter and cardinal septa. These features clearly distinguish it from *S. hongi*. *S. pauciradialus* and *S. hongi* are, however, remarkably similar at the generic level, both having the lateral attachments of some corallites to others seen in cross section. Unfortunately, the holotype of *S. hongi* occurred in rock near an intrusion and is highly silicified, with well-developed quartz crystals in some vuggy places, so that features of all the corallites are not preserved.

I know of no other Permian species with which *S. hongi* can be compared. This single corallum appears to be the first record of *Siphonodendron* in the Permian.

Etymology. The species is named for Mr. Chang Ki Hong.

Genus *Yatsengia* Huang, 1932

Yatsengia fletcheri n. sp.

Figures 31c–d

Diagnosis. A species of *Yatsengia* characterized by the combination of large corallites, a large number of septa, and a relatively broad and continuous disepimentarium. It has larger corallites and more major septa than *Y. kenneyi* n. sp. It has larger corallites and a broader, more continuous dissepimentarium than *Y. scheetzi* n. sp. It has larger corallites and more septa than species of the genus described from Asia.

External Description. Corallum phaceloid, maximum observed diameter 5 cm; corallites subparallel, closely spaced; epitheca and calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 12 to 15 mm, closely spaced, touching to as much as 3 mm apart; septa of 2 orders, 24 to 27 each, thin in dissepimentarium, dilate in tabularium; major septa confluent with septal lamellae, 4.5 to 5.5 mm long, about 0.5 mm wide at periphery of tabularium; minor septa short, 0.7 to 1.5 mm long, confined to dissepimentarium except axial ends dilate and join laterally with major septa to form false wall; dissepimentarium regular, lacking in parts of some corallites; dissepiments straight, concentric, angulo-concentric, pseudoherringbone; axial structure aulophylloid, large; septal lamellae sinuous, confluent with major septa, generally thin, rarely dilate, number equal to or fewer than number of major septa; false wall stereozone as much as 1 mm wide, formed of dilate axial ends of minor septa and dilate peripheral ends of major septa in tabularium, with ends of minor septa either exposed axially to tabularium or covered by extensions of major septa; corallite wall about 0.1 mm wide, with bases of major and minor septa fitted into V-shaped grooves; microstructure of septa fibrous, with fibers at right angles to straight or somewhat sinuous central line.

Longitudinal Section Description. Dissepimentarium of 1 to 3 ranks of steeply dipping, various sized, noninflated dissepiments; tabellae in 2 zones; axial tabellae of 1 to 3 ranks, elongate, steeply inclined inwards and upwards to septal lamella (?) or medial plate (?); periaxial tabellae in 1 to 3 ranks, gently inclined inwards and upwards to axial tabellae; calyx about 8 mm deep, with narrow pointed axial boss about 5 mm high.

Documentation. UCMP holotype 37211. Two thin sections and 13 polished sections from one corallum from UCMP locality D-858 were studied.

Discussion. This species and the following two are referred to *Yatsengia* on the basis of comparisons with the figures and description of the type species, *Y. asiatica* (Huang, 1932:56, pl. 5, fig. 1) and other discussions and figures of this and other species by Yoh (in Yoh and Huang, 1932:32, pl. 9, figs. 3a–3c), Minato

(1955: 117–120, pl. 18, figs. 7–10; pl. 29, figs. 1–4; pl. 37, fig. 10; pl. 41, fig. 3; pl. 43, fig. 3; text-figs. 9A–9M), and Fontaine (1961: 138–143, pl. 8, figs. 3, 4; pl. 9, fig. 4–6; pl. 10, figs. 1, 2; pl. 32, figs. 3–5; pl. 33, figs. 3, 4). These authors erected species from China (the type locality), Japan, and Cambodia. Fontaine (1961:140) also considered the genus to be present in Iran and Turkey. All occurrences seem to be in Permian rocks, ranging from Lower to Upper.

Yatsengia has not heretofore been recorded from North America. My reference of three McCloud Limestone species to it is based on their similarity to the Asiatic species in having axial structures with most septa joined to septal lamellae, apparent lack of medial plates in most axial structures, narrowness or impersistency of the dissepimentaria, shortness of the minor septa, general presence of an excentric false wall, and lack of fossulae or shortened cardinal septa.

It has not been possible to compare the microstructure closely.

Y. fletcheri has a larger corallite diameter (12 to 15 mm) than the Asiatic species of *Yatsengia* (4 to 8.7 mm) and has more septa than any of them (24 to 27 compared with 13 to 20). The differences with *Y. kenneyi* n. sp. are discussed under that species, which is apparently lower in the section although still Wolfcampian. *Y. scheetzi* n. sp., also from the McCloud Limestone, is apparently higher in the section, although also still Wolfcampian, and has smaller corallite diameters (7 to 11 mm) and a much less continuous dissepimentarium than *Y. fletcheri*.

Etymology. The species is named for Mr. William Fletcher.

Yatsengia kenneyi n. sp.

Figures 31e; 32a–b

Diagnosis. A species of *Yatsengia* characterized by the combination of relatively small corallites, a relatively small number of major septa, and a relatively continuous dissepimentarium. It has smaller corallites and more major septa than *Y. fletcheri*. It has somewhat smaller corallites, somewhat fewer septa, and a more continuous dissepimentarium than *Y. scheetzi* n. sp. It has larger corallites and more septa than species of the genus described from Asia.

External Description. Corallum phaceloid, maximum observed diameter 10 cm; corallites generally parallel, closely spaced; epitheca rather smooth with widely spaced rugae; calyx not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 7.5 to 9.5 mm, closely spaced, touching to as much as 8 mm apart; septa of 2 orders, 17 to 20 each, thin in dissepimentarium, slightly dilate in tabularium; major septa 2.0 to 2.5 mm long, generally confluent with septal lamellae; minor septa short, 0.5 to 0.7 mm long, generally confined to dissepimentarium, rarely extending slightly into tabularium as short nubs, axial ends coalescing with lateral extensions of major septa at dissepimentarium-tabularium interface to form prominent false wall stereozone where dissepimentarium present; dissepimentarium regular, absent in parts of some corallites; dissepiments angulo-concentric, concentric, pseudoherringbone, straight; axial structure apparently aulophylloid, large, with irregular septal lamellae generally connected with major septa (if true medial plate is present, it is too sinuous to be discernible); false wall stereozone as much as 0.7 mm wide, formed of expanded axial ends of minor septa and bases of major septa in tabularium; corallite wall about 0.3 mm wide, with bases of major and minor septa fitted into V-shaped grooves; microstructure of septa fibrous, with fibers at right angles to straight or slightly sinuous central line.

Longitudinal Section Description. Dissepimentarium of 1 to 3 ranks of steeply dipping, various sized, noninflated dissepiments (transverse sections show that it is not present in parts of some corallites, but this not observed in longitudinal sections available); tabellae of 2 zones, boundary irregular in places; axial tabellae of 1 to 2 ranks, various sizes, steeply inclined inwards and upwards to 1 or more thin septal lamellae (medial plate?); periaxial tabellae large or small, in 1 to 3 ranks, inclined inwards and upwards to axial tabellae.

Documentation. UCMP holotype 37212. Three thin sections and 36 polished sections from one corallum from UCMP locality D-805 were studied.

Discussion. *Y. kenneyi* differs from the type and other Asiatic species in its generally greater corallite diameters (7.5 to 9.5 mm compared to 4 to 8.7 mm), generally greater number of septa (17 to 20 major septa compared to 13 to 20), and other characters. It may be distinguished from the two other new species from the McCloud Limestone by its smaller corallite diameters (7.5 to 9.5 mm compared to 12 to 15 mm for *Y. fletcheri* and 7 to 11 mm for *Y. sheetzi*) and fewer number of major septa (17 to 20 compared to 24 to 27 for *Y. fletcheri* and 18 to 26 for *Y. scheetzi*). The dissepimentarium is more discontinuous in *Y. scheetzi* than in *Y. kenneyi*.

Etymology. The species is named for Mr. Paul Kenney.

Yatsengia scheetzi n. sp.

Figures 32c–g; 33a

Diagnosis. A species of *Yatsengia* characterized by the combination of moderately large corallites, a large number of major septa, and a very discontinuous dissepimentarium. It has larger corallites, more major septa, and a less continuous dissepimentarium than *Y. kenneyi*. It has smaller corallites and a less continuous dissepimentarium than *Y. fletcheri*. It has larger corallites and more septa than species of the genus described from Asia.

External Description. Corallum phaceloid, maximum observed diameter 10 cm; corallites subparallel to parallel, closely spaced; calyx and epitheca not observed.

Transverse Section Description. Corallites circular to subcircular, diameter 7 to 11 mm, closely spaced, touching to 3 mm apart; septa of 2 orders, 18 to 26 each, lanceolate throughout; major septa 2.5 to 3.5 mm long, about 0.5 mm wide at base where lanceolate, many confluent with septal lamellae in largest corallites, cardinal and/or counter septa only touch axial structure in smaller corallites; minor septa 0.5 to 0.8 mm long, width where lanceolate as in major septa; dissepimentarium very discontinuous, present only in parts of some corallites; dissepiments straight or pseudoherringbone; axial structure generally aulophylloid, some clisiophylloid or dibunophylloid; medial plate where present thin to slightly dilate, straight to very sinuous;

septal lamellae number 1 to 10, straight to very sinuous, attached to major septa in some large corallites, generally not in smaller corallites; false wall stereozone thin or not present due to discontinuity of dissepimentarium; corallite wall denticulate, with septa set in V-shaped grooves; microstructure of septa fibrous, with fibers at right angles to straight or somewhat sinuous central line.

Longitudinal Section Description. Dissepimentarium discontinuous, may be absent for as much as 1 cm; where present, of 1 to 2 ranks of small, steeply dipping dissepiments, numbering about 6 in 0.5 cm; tabellae of 2 zones; axial tabellae of 1 to 2 ranks, steeply to gently inclined inwards and upwards to medial plate (where present); periaxial tabellae of 2 to 3 ranks, more gently inclined inwards and upwards to axial tabellae, various sizes; corallite wall as much as 0.7 mm wide.

Documentation. UCMP holotype 37213, UCMP paratypes 37214–37218, LACMIP paratype 6416. Seven thin sections and numerous polished sections from seven coralla from UCMP localities D-834 (paratype 37218), D-836 (holotype 37213, paratypes 37214, 37216), and D-838 (paratypes 37215, 37217) and LACMIP locality 1114 (paratype 6416) were studied.

Discussion. The nature of the axial structure in this species, which ranges from aulophylloid through clisiophylloid and dibunophylloid, is troublesome, but all types are present in some coralla and therefore demonstrate that the variation is natural. Two figures of the holotype of *Yatsengia asiatica* Huang, 1932 (pl. 5, figs. 1a, 1b), seemingly show a similar variation.

Y. scheetzi is larger than the Asiatic species and has a greater number of septa. It has somewhat larger corallites than *Y. kenneyi* (7 to 11 mm compared to 7.5 to 9.5 mm) and has more septa (18 to 26 major septa compared to 17 to 20). It has smaller corallites than *Y. fletcheri,* which ranges from 12 to 15 mm in diameter, and has generally fewer septa (*Y. fletcheri* has 24 to 27). The dissepimentarium of *Y. scheetzi* is more discontinuous and narrower than those of the other two species of *Yatsengia* from the McCloud Limestone.

Etymology. The species is named for Mr. James Scheetz.

Cerioid Rugosa

Genus *Bassius* n. gen.

Diagnosis. *Bassius* is a cerioid rugose coral with two orders of septa, clisiophylloid axial structure, wide lonsdaleoid dissepimentarium, thin wall, tabellae of two ranks—axial and periaxial, the former generally clustered dissepiment-like around the columella, the latter generally flat, domed, or slightly sagging, horizontal or sloping inwards and upwards, rarely sloping inwards and downwards.

Type Species. *Bassius mccloudensis* n. sp.

Description. As for the type and only species firmly referred to the genus.

Discussion. *Kleopatrina (Porfirievella)* is similar in some characters to *Bassius,* but the latter has a wide and more consistently developed lonsdaleoid dissepimentarium and a much thinner corallite wall. The separation of *Kleopatrina* into two subgenera is largely a subjective matter based on the presence of more or fewer septa that cross the dissepimentarium to the corallite wall. Even the most lonsdaleoid species of *Kleopatrina,* such as *K. (Porfirievella) arcturusensis* Stevens, 1967, from the Lower Permian of eastern Nevada, have ". . . in large corallites generally less than one-half of the major septa extend to the theca" (Stevens, 1967:427).

Ipciphyllum Hudson, 1958, shares some characters with *Bassius,* but the former is not lonsdaleoid. *Wentzellophyllum* Hudson, 1958, is cerioid, clisiophylloid, and lonsdaleoid, but it has tertiary septa, which *Bassius* lacks. *Wentzelella* Grabau in Huang, 1932, has both teritary septa and a mostly regular dissepimentarium, unlike *Bassius,* which has neither. *Ipciphyllum, Wentzellophyllum,* and *Wentzelella* are Permian and from the classic Tethys area. Only the former genus has been reported in North America (*Ipciphyllum tschernyschewi* Minato, 1960, from the Arctic Islands of the Northwest Territories, Canada).

Lonsdaleia M'Coy, 1849, is a Mississippian coral, the type species of which is fasciculate, although Hill (1956:306) would include cerioid coralla in it as well. I consider fasciculate and cerioid coralla to be generic characters and on this basis alone differentiate *Lonsdaleia* from *Bassius,* but in addition they are dissimilar in many other ways. *Lonsdaleia* is restricted to the Carboniferous by most paleontologists.

Hudson (1958:182) referred a specimen from the Permian of northern Iraq to *'Lonsdaleia' chaoi* Huang var. The species of Huang (in Yoh and Huang, 1932:35), from the Permian of China, has an aulophylloid axial structure, and the specimens of Hudson are clisiophylloid (Hudson, 1958:183), which are generic differences. Minato and Kato (1965a:211) referred Huang's species to *Wentzelophyllum* and noted that it has tertiary septa. Both these species were reported by Hudson (1958) and Minato and Kato (1965b) to have "clinotabulae" (clinotabellae), a name proposed by Hudson (1958:177) for periaxial tabellae that slope downwards and inwards to the axial tabellae and form a deep groove around the axial boss, as shown in Hudson's (1958, pl. 33, figs. 4a, 4b) reference to his figure of *Waagenophyllum indicum* (Waagen and Wentzel, 1886) as having examples of these structures. Occasional tabellae sloping downwards and inwards in a coral in which they generally slope upwards and inwards do not form the deep groove of *Waagenophyllum* Hayasaka, 1925, and, in my opinion, should not be considered clinotabellae or heavily weighed systematically. I think that the specimens referred to by Hudson (1958:182) as *'Lonsdaleia' chaoi* Huang var. do not have clinotabellae, since his figures (Hudson, 1958, pl. 32, fig. 1 and text-figs. 3c–3d) show no such groove.

Minato and Kato (1965a:211) erected *Wentzelophyllum* (?) *gelikhanense* for the *'Lonsdaleia' chaoi* Huang var. of Hudson from Iraq and described tertiary septa "locally found along walls as mere short septal ridges." I see no certain evidence of tertiary septa in Hudson's (1958, pl. 32, fig. 2) best transverse section of the holotype. If tertiary septa are lacking, then perhaps *W.* (?) *gelikhanense* should be referred to *Bassius.* The thin sections of the holotype should be examined.

Minato and Kato (1965a:213) named *Wentzelophyllum* (?) *tabasense* for a coral from the Permian of Iran. They noted (Minato and Kato, 1965a:215) that it ". . . lacks any trace of the tertiary septa . . . typical to the genus *Wentzelophyllum.*" Their figures (Minato and Kato, 1965a, pl. 20) show transverse and

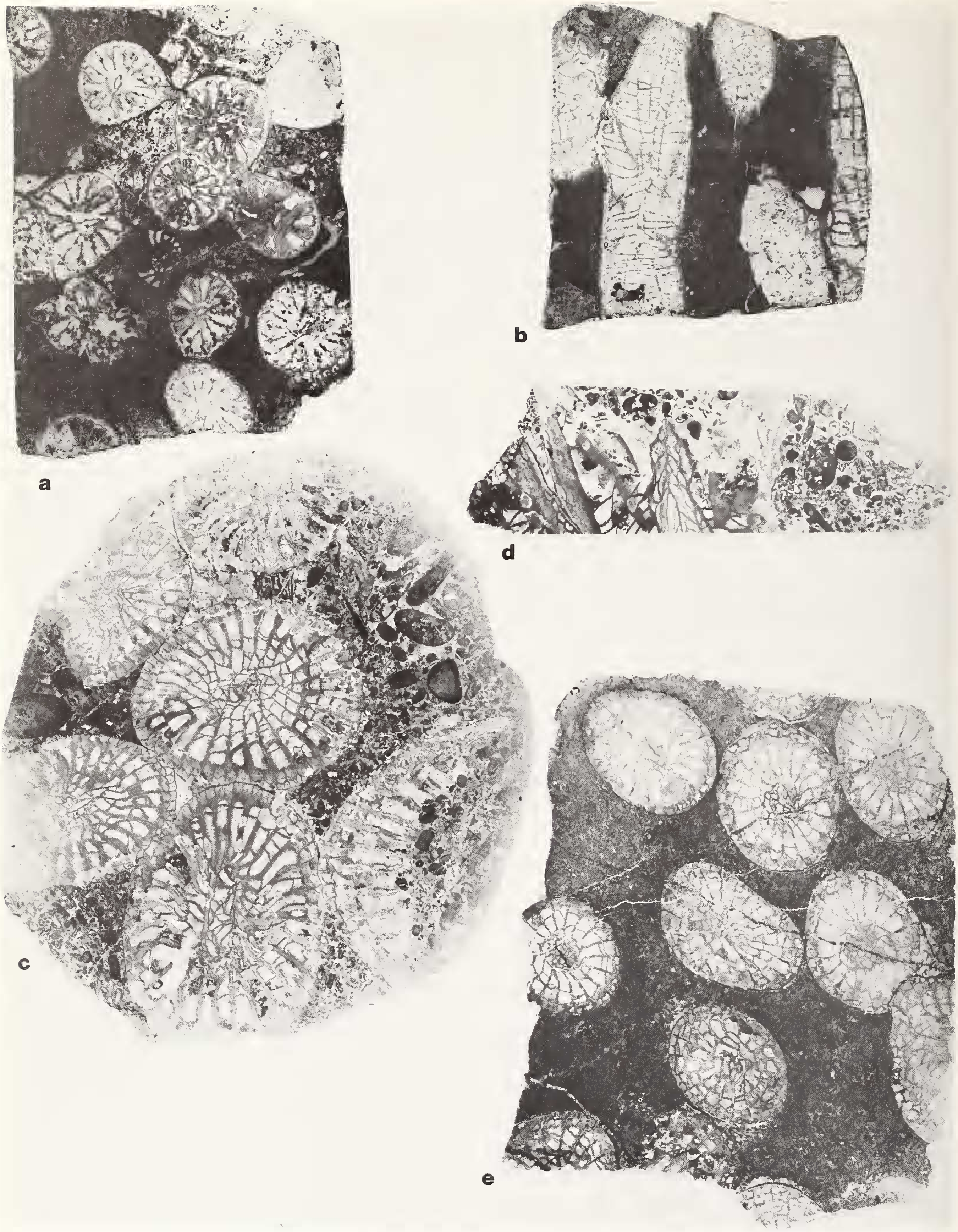


Figure 31. *Siphonodendron hongi* n. sp., *Yatsengia fletcheri* n. sp., and *Y. kenneyi* n. sp. All parts x3.
Parts a and b. *S. hongi* n. sp., UCMP holotype 37210, transverse section (a; note *Pseudoschwagerina* at center) and longitudinal section (b).
Parts c and d. *Y. fletcheri* n. sp., UCMP holotype 37211, transverse (c) and longitudinal (d) sections.
Part e. *Y. kenneyi* n. sp., UCMP holotype 37212, transverse section.

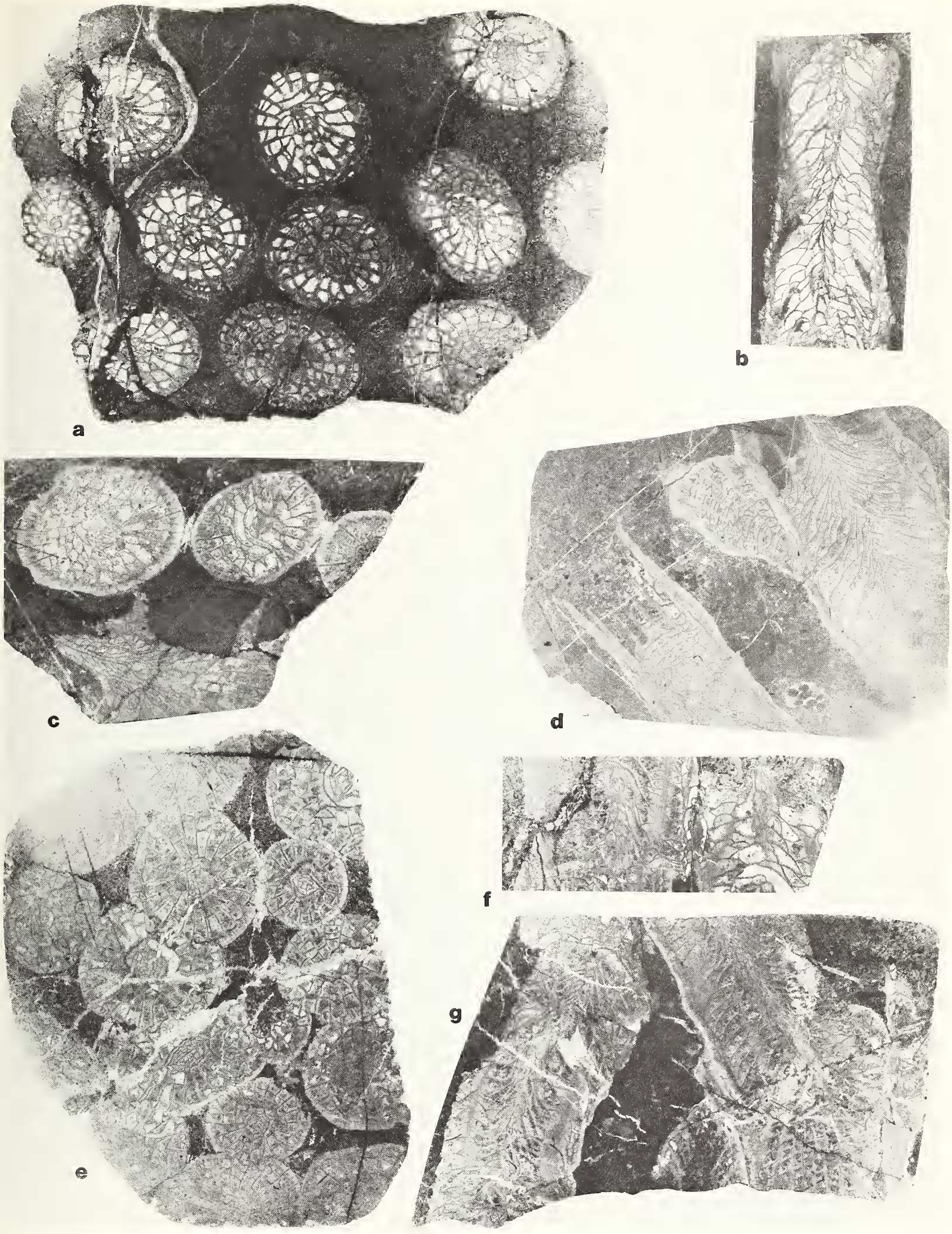
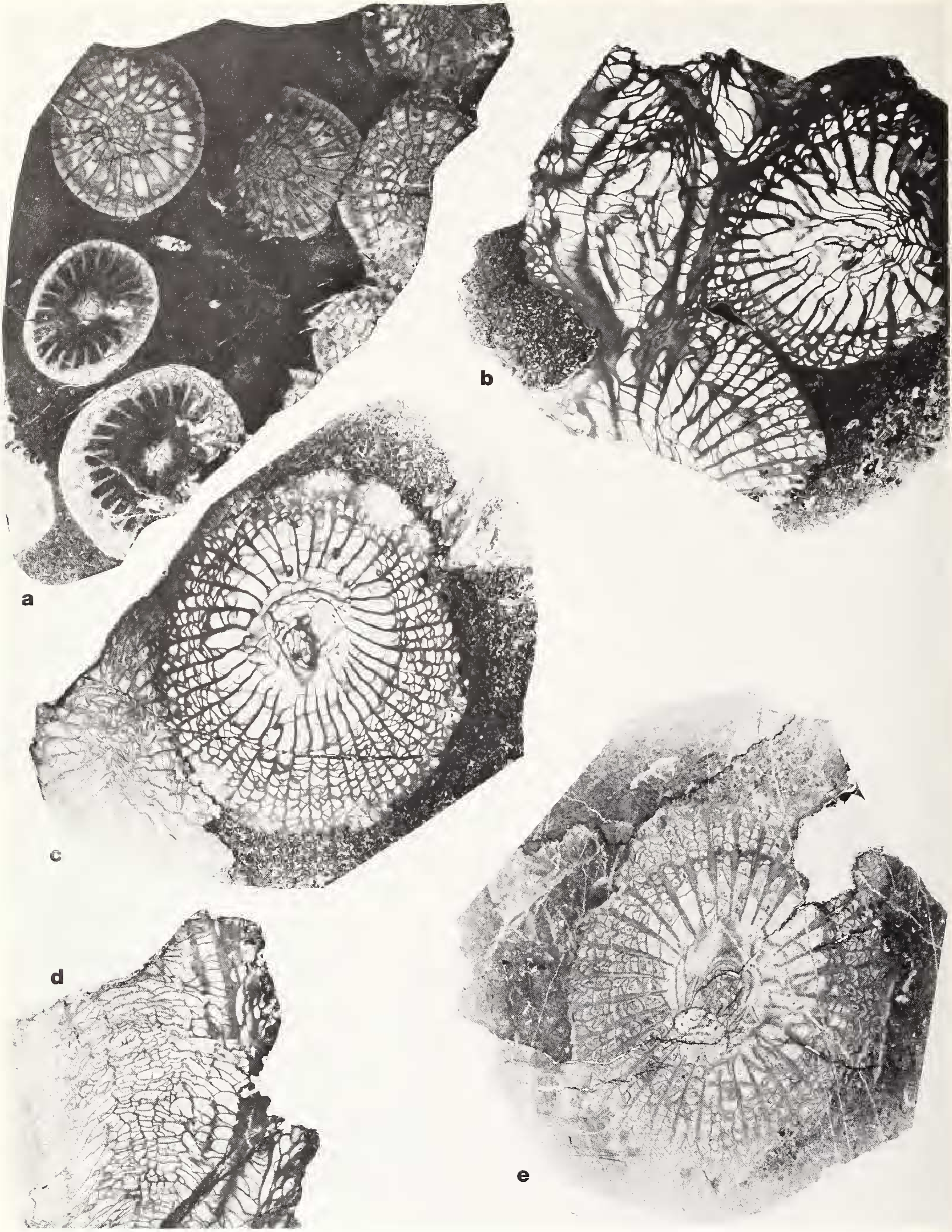


Figure 32. *Yatsengia kenneyi* n. sp. and *Y. scheetzi* n. sp. All parts x3.

Parts a and b. *Y. kenneyi* n. sp., UCMP holotype 37212, transverse (a) and longitudinal (b) sections.

Parts c through g. *Y. scheetzi* n. sp. **Parts c and d,** UCMP holotype 37213, transverse (c) and longitudinal (d) sections. **Parts e through g,** UCMP paratype 37214, transverse (e) and longitudinal (f, g) sections.


a
b
c
d
e

longitudinal sections with characters similar to *Bassius*. The longitudinal sections lack what I consider to be clinotabellae, although Minato and Kato considered them to be present. This holotype also should be examined for possible inclusion in *Bassius*.

If the two species from Iraq and Iran should prove to be referable to *Bassius*, then this would be a rare instance of true Tethys massive corals occurring both there and in North America.

Etymology. The genus is named for Mr. John S.P. Bass.

Bassius mccloudensis n. sp.

Figures 34a–c

Diagnosis. Because the genus *Bassius* is erected as monotypic, the diagnoses of the genus and of the type species are identical.

External Description. Corallum cerioid, hemispheroidal, maximum observed diameter 4.5 cm; calyx not observed.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 11 to 17 mm wide at greatest diameter; septa of 2 orders; major septa 19 to 25 each, 1.5 to 3 mm long, extending into dissepimentarium 0.5 to 1.0 mm, thin in dissepimentarium (where present), represented in places by septal spines on dissepiments, slightly dilate in tabularium, withdrawn from axial structure; minor septa commonly absent in adult corallites or represented by a few septal spines in outer ranks of dissepiments and on wall, absent in tabularium; axial structure clisiophylloid, oval, 2 to 3 mm long, with well-defined axial plate having 5 to 6 short septal lamellae opposite each other on each side, connected by axial tabellae; dissepimentarium highly lonsdaleoid, 3 to 4 mm wide; dissepiments highly lonsdaleoid in peripheral ranks, concave axially, variously sized, with some axial spines, concentric, angulo-concentric, or pseudoherringbone near axial part where major septa present; corallite wall thin and smooth or slightly denticulate, entire, 0.1 to 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium of 2 to 5 ranks of small cystose or larger elongate dissepiments, steeply dipping, about 20 per cm; tabellae of 2 series, axial and periaxial; axial tabellae clustered about columella dissepiment-like or sloping steeply inwards and upwards, 1 to 3 ranks each side; periaxial tabellae flat, domed, or slightly sagging, generally sloping inwards and upwards to axial tabellae, rarely sloping inwards and downwards, about 20 per cm.

Documentation. UCMP holotype 37219. Three thin sections and 19 polished sections from one corallum from UCMP locality D-181 were studied.

Discussion. The only two species known to me with which this species might be compared are from the Permian of Iran and Iraq and have been discussed above under "Remarks" for the genus. It is uncertain if they may be referred to *Bassius*, but if they should be, then the most obvious difference would be that *B. mccloudensis* has no minor septa in the tabularium whereas both of the other species have well-developed minor septa there.

Etymology. The species is named for the McCloud River.

Genus *Dillerium* n. gen.

Diagnosis. *Dillerium* is a cerioid coral with two orders of septa, a styliform columella, a regular dissepimentarium, and tabulae that slope inwards and upwards.

Type Species. *Dillerium potterensis* n. sp.

Description. As for the type species since the genus is described as monotypic.

Discussion. *Dillerium* may be distinguished readily from *Kleopatrina* McCutcheon and Wilson, 1963, by the former's greatly thickened columella and possession of tabulae, whereas the latter has a medial plate, variously abutted by septal lamellae, and two well-defined zones of tabellae. It can be differentiated from other somewhat similar appearing cerioid corals by the lack of three orders of septa, the lack of two or three zones of tabellae (no clinotabellae), the lack of a fossula, the lack of a clisiophylloid, aulophylloid, or dibunophylloid axial structure, the lack of an incomplete wall, and the possession, as described in the diagnosis, of complete walls, two orders of septa, a styliform columella, a regular dissepimentarium, and tabulae.

Etymology. The genus is named for Mr. Joseph S. Diller.

Dillerium potterensis n. sp.

Figures 35a–c

Diagnosis. Because the genus *Dillerium* is erected as monotypic, the diagnoses of the genus and of the type species are identical.

External Description. Corallum cerioid and hemispheroidal; maximum observed diameter 5.5 cm; other external features not preserved.

Transverse Section Description. Corallites 4 to 7 sided, 14 to 16 mm wide at greatest diameter; septa of 2 orders, 13 to 17 each, straight to somewhat sinuous; major septa generally withdrawn from axial structure, 0.5 to 1.5 mm long, generally dilate in tabularium (to 0.15 mm thick), thin in dissepimentarium; minor septa 0.3 to 0.5 mm long, confined to dissepimentarium or extending into tabularium as short spines, thin throughout; dissepimentarium regular, narrow, 0.5 mm wide or less; dissepiments concentric, angulo-concentric, straight, herringbone (rare), or pseudoherringbone (rare); axial structure a highly dilate columella (styliform), round, oval, lenticular in shape, measuring 1.0 by 1.0 mm, 1.0 by 1.5 mm, to 0.5 by 1.5 mm, with dark line in center representing axial plate and, in some, 1 to 3 short dark

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Figure 33. *Yatsengia scheetzi* n. sp. and *Heritschioides* (?) *californiense* (Meek, 1864). All parts x3.

Part a. *Y. scheetzi* n. sp., LACMIP paratype 6416, transverse section.

Parts b through d. *H.* (?) *californiense*, MCZ lectotype, MCZ Meek collection block no. 13, transverse and longitudinal sections (b), transverse section (c), and longitudinal section (d).

Part e. (?) *H. californiense*, UCMP hypotype 37350, transverse section.

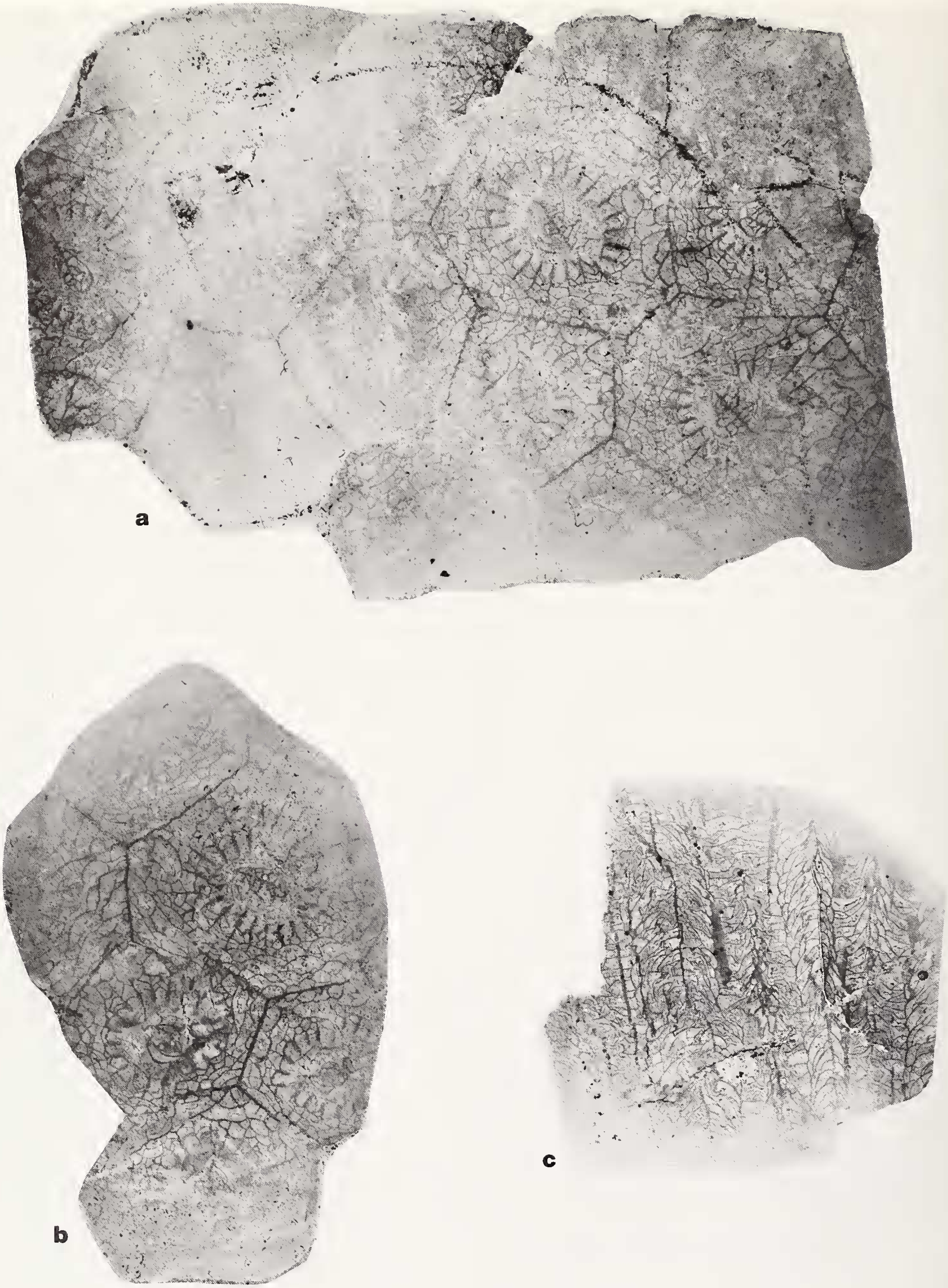


Figure 34. *Bassius mccloudensis* n. gen., n. sp., UCMP holotype 37219, transverse (a, b) and longitudinal (c) sections. All parts x3.

lines representing axial lamellae, not connected to septa; corallite wall 0.15 to 0.3 mm wide, with dark line in center, V-shaped depressions for septal bases.

Longitudinal Section Description. Dissepimentarium of 1 to 2 steeply dipping ranks of small cystose dissepiments; tabulae slope steeply inwards and upwards to columella, generally about 20 per cm.

Documentation. UCMP holotype 37220. Two thin sections and 17 polished sections from one corallum from UCMP locality D-843 were studied.

Discussion. Although the preservation of the corallum on which this new genus and species are based is not very good (somewhat metamorphosed, somewhat crushed), the characters clearly can be made out with some patience. *Dillerium potterensis* is not close to any other species that I have seen, and the genus is erected as monotypic.

Etymology. The species is named after Potter Ridge.

Genus *Kleopatrina* McCutcheon and Wilson, 1963

Subgenus *Kleopatrina* McCutcheon and Wilson, 1963

***Kleopatrina (Kleopatrina) raubae* n. sp.**

Figures 35d–e

Diagnosis. A speeies of *Kleopatrina (Kleopatrina)* characterized by the combination of large corallites, abundant septa, a complex axial structure, and thin septa in the tabularium. It has larger corallites, more septa, and a more complex axial structure than *K. (K.) ftatateeta* and *K. (K.) wilsoni*. It has larger corallites and/or more septa than all the species of the subgenus described from Russia except *K. (K.) magnifica*. It has a more complex axial structure and septa that are thinner in the tabularium than *K. (K.) magnifica*.

External Description. Corallum cerioid, hemispheroidal, maximum observed diameter 8 cm (probably much greater in uncollected specimens); calyx not observed; corallites parallel.

Transverse Section Description. Corallites 4 to 7 sided, 9 to 14 mm wide at greatest diameter; septa of 2 orders, 16 to 23 each, straight to slightly sinuous, rarely lonsdaleoid; major septa generally withdrawn from axial structure, touching in some corallites, 2.5 to 5.5 mm long, slightly dilate in tabularium or thin throughout; minor septa poorly developed (absent in parts of some corallites), 1.0 to 2.0 mm long, generally confined to outer ½ to ¾ of dissepimentarium, but extending into tabularium in places as nubs or spines 0.5 mm long; dissepimentarium generally regular, width 1 to 5 mm, generally about 3 mm; dissepiments concentric, herringbone, pseudoherringbone, or lonsdaleoid (uncommon); axial structure clisiophylloid, circular to subcircular, 1.5 to 2 mm diameter, formed of straight to sinuous, thin or slightly thickened medial plate about 1.5 to 2 mm long with 2 to 8 radiating, straight to sinuous septal lamellae connected by 1 to 2 axial tabellae, generally not touched by axial ends of septa, rarely touched by 1 or more; corallite wall 0.15 to 0.2 mm wide.

Longitudinal Section Description. Dissepimentarium of 4 to 7 steeply to gently dipping ranks of mixed large elongate and large and small cystose dissepiments; tabellae of 2 zones, axial and periaxial; periaxial tabellae flat, gently domed, with straight peripheral edges, rarely small and cystose (sloping in and up to periaxial tabellae where axial, sloping in and up to dissepiments where peripheral), 20 to 30 per cm; axial tabellae in 1 to 3 ranks, large to small, elongate (some cystose), steeply sloping inwards and up to medial plate, 20 to 32 per cm.

Documentation. LACMIP holotype 6417, LACMIP paratypes 6418–6419, UCMP paratypes 37221-37222. Eleven thin sections and 64 polished sections from five coralla from UCMP locality D-842 (paratypes 37221–37222) and LACMIP locality 1122 (holotype 6417, paratypes 6418–6419) were studied.

Discussion. *K. (K.) raubae* can be distinguished from the other McCloud Limestone species of *Kleopatrina* described herein by the absence or relative rarity of lonsdaleoid dissepimentaria. The other new species have predominately lonsdaleoid dissepimentaria, which relegate them to the subgenus *Porfirievella* Minato and Kato, 1965b:71, type species *Wentzelella grandis* Dobrolyubova, 1941 (in Soshkina, Dobrolyubova, and Porfiriev, 1941:197, 264, pl. 52, figs. 1a–1b). Minato and Kato (1968:363) suggested later that their name be changed to *Uralnevadaphyllum* to avoid confusion with *Porfirieviella* Ivanovsky, 1963, which has a one letter difference. ICZN Article 56(a) (International Commission on Zoological Nomenclature, 1964) states that "even if the difference between two genus-group names is due to only one letter, these two names are not to be considered homonyms," therefore the subgeneric name *Porfirievella* of Minato and Kato cannot be invalidated on the grounds given by them and must stand.

Previously, only two North American species have been referred to the nominal subgenus: the type species, *K. ftatateeta* (McCutcheon and Wilson, 1961), from the Lower Permian of east central Nevada, and *K. wilsoni* Minato and Kato, 1965b, from the Lower Permian of southeast Nevada. Both have smaller corallites, fewer septa, and less complex axial structures than *K. raubae*. Minato and Kato (1965b:69) based *K. wilsoni* on a paratype of *K. ftatateeta* but rejected a longitudinal section (McCutcheon and Wilson, 1961, pl. 123, fig. 5) from the same corallum (their holotype), considering it to belong to *K. ftatateeta*, which illustrates the difficulties of achieving objective systematics when working with variable corals.

K. raubae has greater corallite diameters and/or more abundant septa than the Russian species of *K. (Kleopatrina)*, except for *K. (K.) magnifica* (Porfiriev, 1941, in Soshkina, Dobrolyubova, and Porfiriev:199, 265, pl. 53, figs. 1a–1c; pl. 54, figs. 1a–1b) from the Lower Permian of the Ural Mountains. The latter species, however, has a less complex axial structure and septa that are thickened in the tabularium, which distinguish it from *K. (K.) raubae*.

Etymology. The species is named for Mrs. Lenor Raub.

Subgenus *Porfirievella* Minato and Kato, 1965b

***Kleopatrina (Porfirievella) mckibbinae* n. sp.**

Figures 36c–f

Diagnosis. A species of *Kleopatrina (Porfirievella)* characterized by the combination of a generally simple axial structure

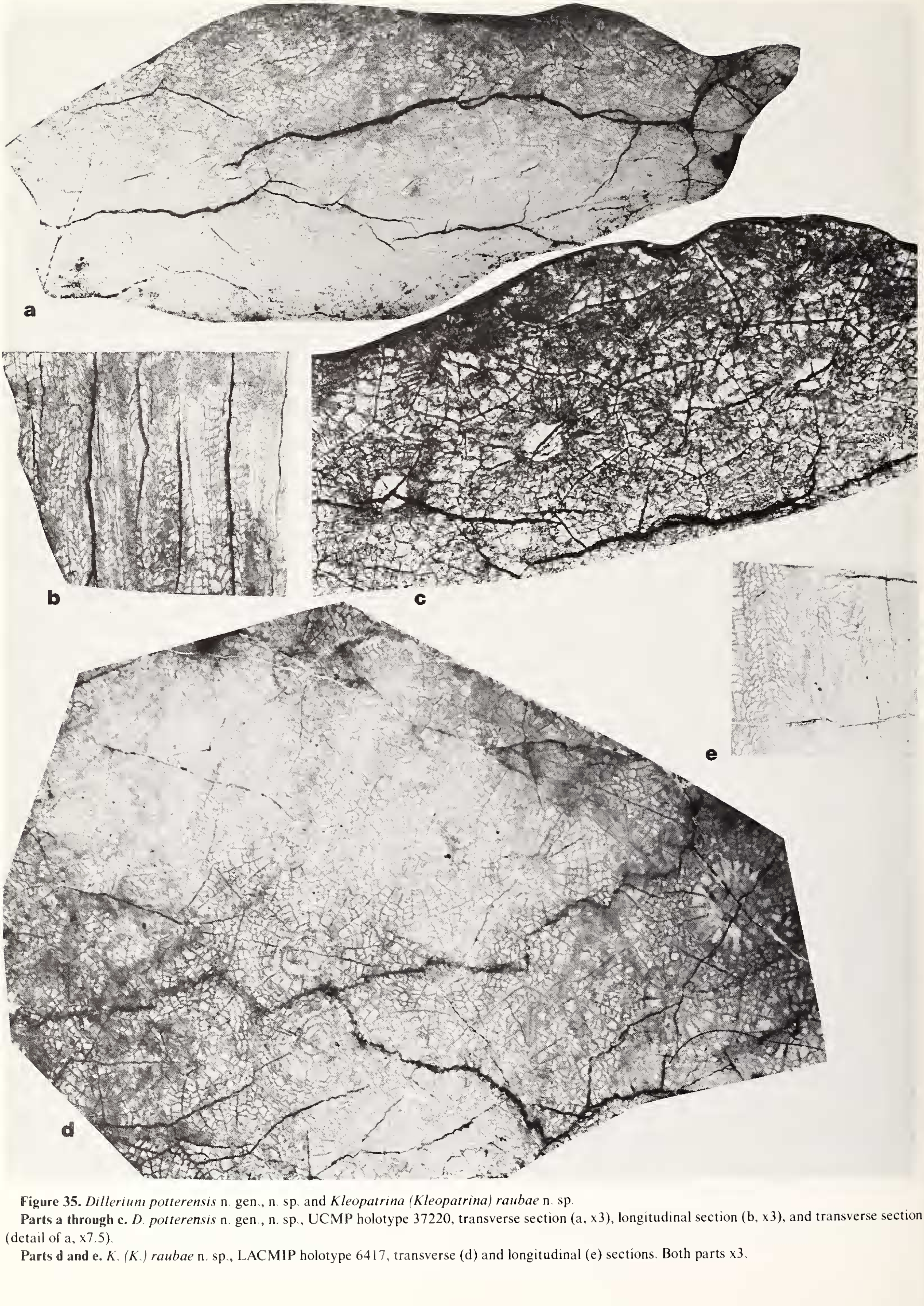


Figure 35. *Dillerium potterensis* n. gen., n. sp. and *Kleopatrina (Kleopatrina) raubae* n. sp.

Parts a through c. *D. potterensis* n. gen., n. sp., UCMP holotype 37220, transverse section (a, x3), longitudinal section (b, x3), and transverse section (detail of a, x7.5).

Parts d and e. *K. (K.) raubae* n. sp., LACMIP holotype 6417, transverse (d) and longitudinal (e) sections. Both parts x3.

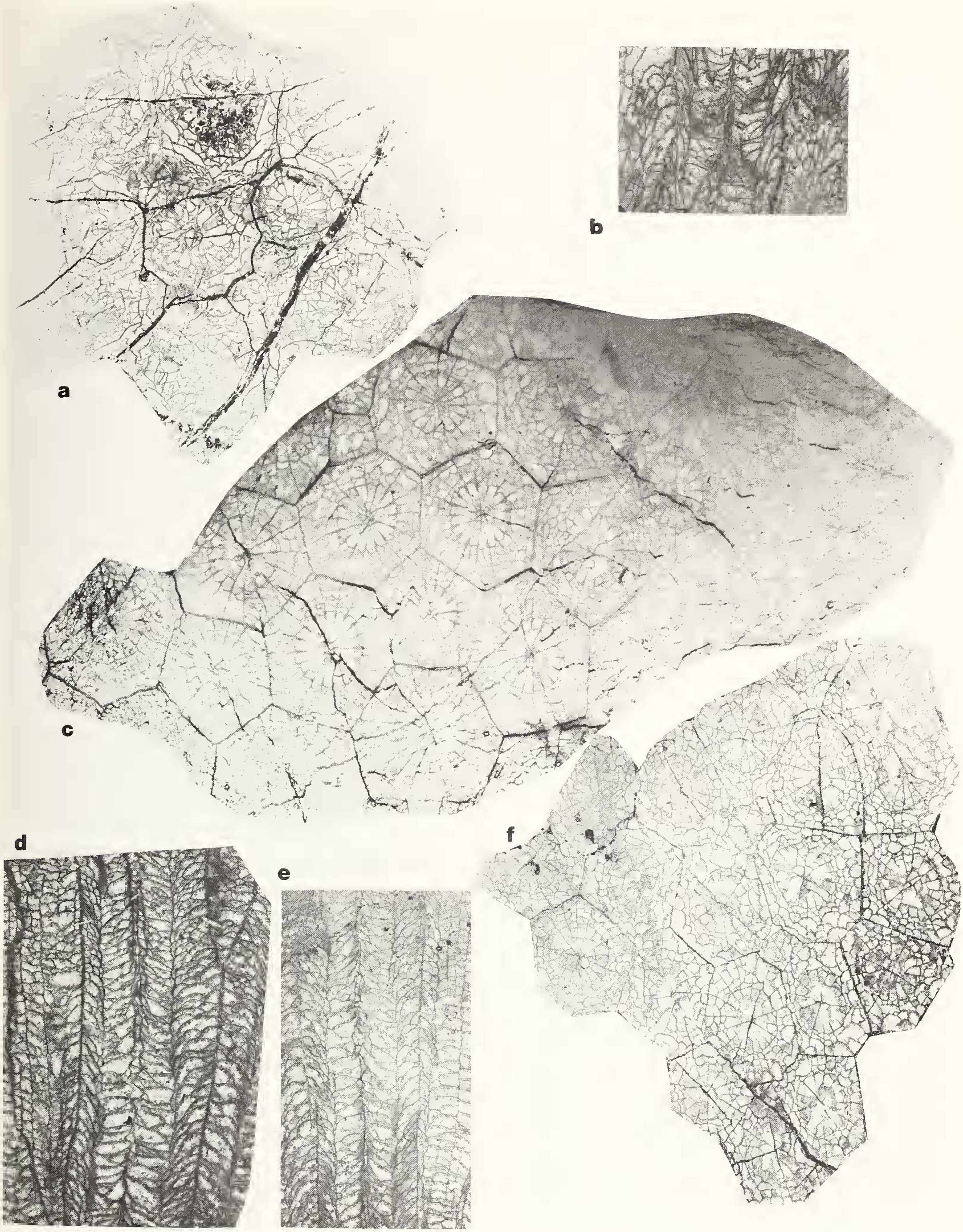


Figure 36. *Kleopatrina (Porfirievella) peggyae* n. sp. and *K. (P.) mckibbinae* n. sp. All parts x3.

Parts a and b. *K. (P.) peggyae* n. sp., UCMP holotype 37223, transverse (a) and longitudinal (b) sections.

Parts c through f. *K. (P.) mckibbinae* n. sp. **Parts c through e,** UCMP holotype 37224, transverse (c) and longitudinal (d, e) sections. **Part f,** LACMIP paratype 6420, transverse section.

touched by many septa and a moderately lonsdaleoid dissepimentarium. It has more septa touching the axial structure and a less lonsdaleoid dissepimentarium than *K. (P.) peggyae* n. sp. and *K. (P.) whitneyi* n. sp. It has a less complex axial structure touched by fewer septa than *K. (P.) illipahensis*. It has a less complex axial structure touched by more septa than *K. (P.) arcturusensis*. It has a smaller and less complex axial structure than *K. (P.) nevadensis*. It has an axial structure touched by more septa than *K. (P.) grandis*, *K. (P.) radiata*, and *K. (P.) stylidophylloides*.

External Description. Corallum cerioid, hemispheroidal to subhemispheroidal, maximum diameter 13 cm (represented by collected fragments, many from much larger coralla), calyx not observed.

Transverse Section Description. Corallites 4 to 7 sided, 6 to 11 mm wide at greatest diameter; septa of 2 orders, 12 to 20 each (generally 15 to 17), straight to somewhat sinuous, absent or represented by spines on dissepiments where lonsdaleoid; major septa nearly all touching axial structure in some corallites, fewer touching in others, some touching in nearly all corallites, 1.5 to 3.5 mm long, generally thin throughout except few somewhat dilate to 0.2 mm thick in tabularium; minor septa poorly developed, absent in parts of many corallites, 0.5 to 1.5 mm long, rarely crossing dissepimentarium; dissepimentarium width 0.5 to 3.0 mm, generally about 2.0 mm; dissepiments concentric, herringbone, pseudoherringbone, lonsdaleoid (common); axial structure variable, elisiophylloid (connected to counter and cardinal septum in many and appearing dibunophylloid), formed of thin to thickened medial plate 1 to 2 mm long, rarely dilate to as much as 0.6 mm, generally simple with 1 to 7 irregularly spaced, short septal lamellae, some without septal lamellae, some with septal lamellae joined by axial tabellae into complex structure, many of which are touched by attenuate septal ends; corallite wall 0.15 to 0.3 mm wide; corallites rarely sciophylloid.

Longitudinal Section Description. Dissepimentarium of 1 to 6 (generally 2 to 4) ranks of large elongate and small and large cystose dissepiments; tabellae poorly zoned in most corallites, not zoned in some; periaxial tabellae flat, domed, horizontal to gently sloping inwards and upwards to axial tabellae, 18 to 30 per cm; axial tabellae steeply sloping inwards and upwards to columella, 18 to 20 per cm; tabulae tent-shaped or domed, about 20 per cm.

Documentation. UCMP holotype 37224, UCMP paratypes 37225–37229, LACMIP paratypes 6420–6423. Twenty-three thin sections and 183 polished sections from 10 coralla from UCMP localities A-7096 (holotype 37224, paratypes 37225–37226, 37228–37229) and D-842 (paratype 37227) and LACMIP localities 1123 (paratypes 6420–6421) and 1124 (paratypes 6422–6423) were studied.

Discussion. The numerous coralla of this species examined show it to be variable in the complexity of the axial structure as seen in transverse and longitudinal sections and the consequent zoning, or lack of zoning, in the tabularium as seen in longitudinal section. The holotype has a relatively complex axial structure for the species. A particularly characteristic feature of the species is the common attachment of both the counter and cardinal septa to the axial structure, giving it a dibunophylloid-like character.

The other three species of *Kleopatrina (Porfirievella)* described herein from the McCloud Limestone are comparable in corallite sizes and septal numbers. The two species from lower in the formation both have much more highly lonsdaleoid dissepimentaria as seen in transverse section and lack the number of septa touching the axial structure. *K. (P.) whitneyi* n. sp.—holotype figured by Meek (1864, pl. 1, figs. 3, 3a)—is somewhat similar in the dissepimentarium, but the axial structure does not show any counter-cardinal septa attachments. Meek's specimen may have come from the Bayha area, but its high degree of silicification is unlike those collected in the Bayha section in this study.

The species of *Kleopatrina (Porfirievella)* from elsewhere show a marked similarity in corallite diameters and septal numbers. However, they differ from *K. (P.) mckibbinae* in the following manners: *K. (P.) illipahensis* (Easton, 1960) from the Lower Permian Pequop Formation of east-central Nevada has a much more complex axial structure that is touched by almost every septum. *K. (P.) arcturusensis* Stevens, 1967, from the Lower Permian Arcturus Formation of east-central Nevada also has a more complex axial structure and septa that are more withdrawn from it. *K.* (*P.*) *nevadensis* Stevens, 1967, from the Lower Permian Arcturus (?) Formation of east-central Nevada has a much larger and far more complex axial structure. *K. (P.) grandis* (Dobrolyubova, 1941) from the Lower Permian of the Ural Mountains of Russia, the type species of the subgenus, has fewer septa touching the axial structure. *K. (P.) stylidophylloides* (Dobrolyubova, 1941) and *K. (P.) stylidophylloides* var. *radiata*. (Porfiriev, 1941), also from the Permian of the Ural Mountains, likewise have axial structures that are more withdrawn from the axial ends of the septa.

Etymology. The species is named for Mrs. Jean McKibbin.

Kleopatrina (Porfirievella) peggyae n. sp.

Figures 36a–b

Diagnosis. A species of *Kleopatrina (Porfirievella)* characterized by the combination of a simple axial structure touched by few septa and a highly lonsdaleoid dissepimentarium. It has a simpler axial structure touched by fewer septa than *K. (P.) zulloi* n. sp. It has a more lonsdaleoid dissepimentarium than *K. (P.) whitneyi* n. sp. and *K. (P.) mckibbinae*. It has a simpler axial structure than *K. (P.) illipahensis*, *K. (P.) arcturusensis*, and *K. (P.) nevadensis*. It has thinner septa and a more lonsdaleoid dissepimentarium than *K. (P.) grandis*. It has more septa and a more lonsdaleoid dissepimentarium than *K. (P.) stylidophylloides* var. *radiata*.

External Description. Corallum cerioid, maximum observed diameter 10 cm; no well-preserved calices or wall observed.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 7 to 11 mm wide at greatest diameter; septa of 2 orders; major septa number 17 to 18, 2 to 3 mm in length, extending into tabularium 1 to 1.5 mm, thin in dissepimentarium, thin or slightly dilate in tabularium; minor septa absent or represented by septal spines on wall, dissepiments, and (rare) false wall, fewer than major septa; axial structure variable: columella or medial plate alone, dilate or thin, straight or slightly sinuous, or simplified clisiophylloid with 1 to 4 short septal lamellae; dissepimentarium lonsdaleoid; corallite wall denticulate, 0.3 to 0.5 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 4 ranks of inflated dissepiments; dissepiments number about 8 in 1 cm; tabellae of 2 series; axial tabellae small, 1 to 3 ranks on each side of columella, steeply dipping; periaxial tabellae generally horizontal or sloping inwards and upwards to axial tabellae; columella sinuous.

Documentation. UCMP holotype 37223. Two thin sections and 21 polished sections from one corallum from UCMP locality D-827 were studied.

Discussion. *K. (P.) peggyae* has thinner walls, a thinner axial plate, fewer septa touching the axial structure, and generally a simpler axial structure than *K. (P.) zulloi* n. sp. from the Hirz Mountain section. It is more highly lonsdaleoid and differs in other characters from *K. (P.) whitneyi* n. sp. from south of the Pit River and *K. (P.) mckibbinae* from the Potter Ridge section.

K. (P.) illipahensis, K. (P.) arcturusensis, and *K. (P.) nevadensis* from eastern Nevada have more complex axial structures than *K. (P.) peggyae.*

The Russian species of the subgenus are not very similar to this species. *K. (P.) grandis,* type species for the subgenus, has major septa dilated in the tabularium and is somewhat less lonsdaleoid. *K. (P.) stylidophylloides* var. *radiata* has somewhat fewer septa and a less lonsdaleoid dissepimentarium.

Etymology. The species is named for Mrs. Peggy McCain.

Kleopatrina (Porfirievella) whitneyi n. sp.

Figures 5:3, 3a; 15f; 37a–b

Lithostrotion mamillare? Meek, 1864, plate 1, figs. 3, 3a.

Diagnosis. A species of *Kleopatrina (Porfirievella)* characterized by the combination of a simple axial structure touched by few septa and a moderately lonsdaleoid dissepimentarium. It has an axial structure touched by fewer septa and a less lonsdaleoid dissepimentarium than *K. (P.) zulloi* n. sp. It has a less variable axial structure and a less lonsdaleoid dissepimentarium than *K. (P.) peggyae.* It has an axial structure touched by fewer septa than *K. (P.) mckibbinae.* It has a simpler axial structure than *K. (P.) arcturusensis, K. (P.) illipahensis,* and *K. (P.) nevadensis.*

External Description. Corallum cerioid, maximum observed diameter 3 cm; calices and epitheca not observed.

Transverse Section Description. Corallites polygonal, 4 to 7 sided, 6 to 11 mm wide at greatest diameter; septa of 2 orders; major septa number 17 to 20, total length 2 to 5 mm, extending into dissepimentarium 0.5 to 1.5 mm; generally withdrawn from axial structure; minor septa same number or fewer than majors, extending into tabularium about 0.3 mm in some corallites, absent in tabularium of others, represented in places only by septal spines on dissepiments; axial structure clisiophylloid, with sinuous medial plate 1.5 to 2 mm long; septal lamellae absent or maximum of 6, short, loosely connected by axial tabellae; dissepiments highly lonsdaleoid in parts of some corallites, not lonsdaleoid in others but straight, angulo-concentric, pseudoherringbone, herringbone; dissepimentarium about 4 mm wide at greatest width; wall rather sinuous, not denticulate, about 0.2 mm wide.

Longitudinal Section Description. Dissepiments of 1 to 6 ranks of steeply dipping, small or inflated dissepiments; tabellae of 2 zones, axial and periaxial; axial tabellae large, of 1 rank, sloping upwards to the columella, rarely continuous with periaxial tabellae to form tabulae; periaxial tabellae horizontal in places, generally sloping inwards and upwards gently to axial tabellae, about 16 per cm; columella sinuous.

Documentation. Two thin sections and several polished sections from the holotype corallum, MCZ Meek collection specimen no. 15, were studied. This specimen was labeled "No 15 *Lithostrotion mamillare* Castlenau ? sp." and is not the "*Lithostrotion* ____?" of Meek (1864:7), which he indicated is figured on his plate 1, figures 3, 3a. The specimen labeled "*Lithostrotion* ____?" is a fasciculate coral and was not figured by Meek.

The type locality is uncertain but probably is somewhere in the McCloud Limestone south of the Pit River at one of the localities collected by the Whitney Survey in September 1862. Other coralla of this species were not collected by me, and the high degree of silicification suggests that the specimen did not come from my Bayha section, where few corals are so highly silicified. Unfortunately, no fusulinids are associated with the holotype, but the formation in this area is within the fusulinid zones E and F. Cerioid corals are common in places in zone F of the Bayha section.

Discussion. *K. (P.) whitneyi* can be distinguished from the other three new species of the subgenus from the McCloud Limestone by the number of septa in contact with the axial structures and the degree of lonsdaleoid development of the dissepimentaria as well as other features. *K. (P.) zulloi* n. sp. from the Hirz Mountain section has many more septa that touch the axial structure and is much more lonsdaleoid. *K. (P.) peggyae* from Bollibokka Mountain has a much more lonsdaleoid dissepimentarium and a different kind of axial structure. *K. (P.) mckibbinae* from the Bayha and Potter Ridge sections has many more septa that touch the axial structure. *K. (P.) illipahensis, K. (P.) arcturusensis,* and *K. (P.) nevadensis,* all from the Lower Permian of Nevada, have more complex axial structures and other differences.

Etymology. The species is named for Mr. Josiah Dwight Whitney.

Kleopatrina (Porfirievella) zulloi n. sp.

Figures 37c–e

Diagnosis. A species of *Kleopatrina (Porfirievella)* characterized by the combination of a moderately simple axial structure touched by many septa and a highly lonsdaleoid dissepimentarium. It has longer septa, a more complex axial structure touched by more septa, and more inflated dissepiments than *K. (P.) peggyae.* It has a more lonsdaleoid dissepimentarium than *K. (P.) mckibbinae* and *K. (P.) whitneyi.* It has a simpler axial structure than *K. (P.) arcturusensis, K. (P.) illipahensis,* and *K. (P.) nevadensis.*

External Description. Corallum cerioid, maximum observed di-

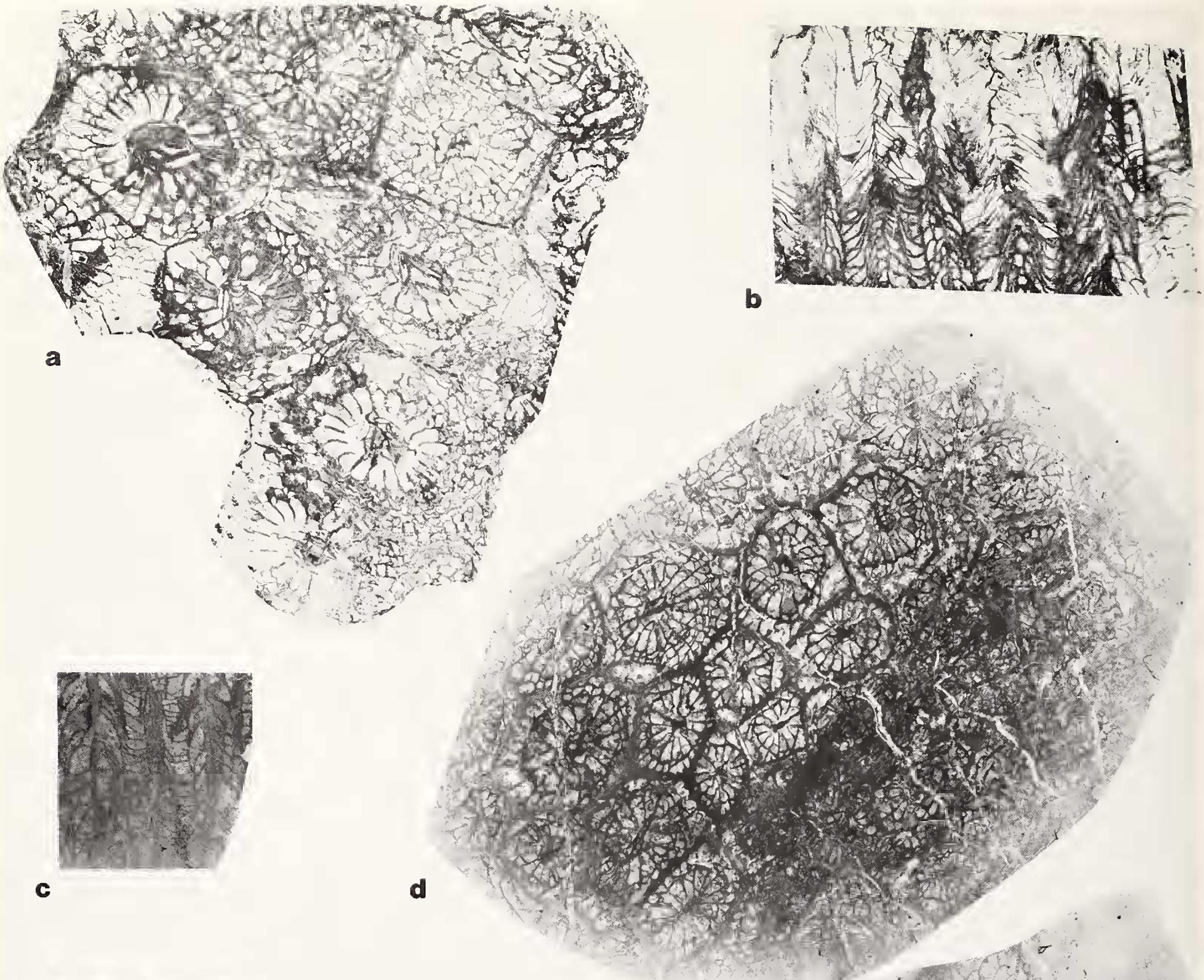


Figure 37. *Kleopatrina (Porfirievella) whitneyi* n. sp., *K. (P.) zulloi* n. sp., and *Langenheimia klamathensis* n. gen., n. sp. All parts x3.
Parts a and b. *K. (P.) whitneyi* n. sp., MCZ holotype, MCZ Meek collection corallum no. 15, transverse (a) and longitudinal (b) sections.
Parts c through e. *K. (P.) zulloi* n. sp., UCMP holotype 37230, longitudinal (c, e) and transverse (d) sections.
Part f. *L. klamathensis* n. gen., n. sp., UCMP holotype 37231, longitudinal section.

ameter 15 cm, calyx 2 to 3 mm deep, with steeply sloping walls, rather flat floor, tall central axial boss, which may be attached to one side of calyx, presumably by counter septum.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 6 to 9 mm wide at greatest diameter; septa of 2 orders, 15 to 19 each, thin throughout, or very slightly dilate in tabularium; major septa 1 to 2 mm long, extending into tabularium 0.5 to 0.8 mm; minor septa generally confined to dissepimentarium, about 0.3 mm long; axial structure clisiophylloid, with well-defined medial plate, 1 to 4 septal lamellae, and tabellae (juvenile axial structure a columella attached to counter septum); dissepiments lonsdaleoid in many places, elsewhere concentric and herringbone; corallite wall denticulate, with or without septal spines where lonsdaleoid, 0.2 to 0.3 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 3 (rare) ranks of steeply dipping, generally inflated dissepiments; tabellae of 2 series; axial tabellae dissepiment-like against columella; periaxial tabellae generally flat or sagging, rarely sloping inwards and upwards to the axial tabellae; columella somewhat sinuous.

Documentation. UCMP holotype 37230. Four thin sections and 44 polished sections from one large corallum from UCMP locality D-855 were studied.

Discussion. *K. (P.) zulloi* is similar in some respects to *K. (P.) peggyae* from Bollibokka Mountain. The latter, however, has a simpler axial structure from which the septa are somewhat more withdrawn and generally less inflated dissepiments. *K. (P.) whitneyi* and *K. (P.) mckibbinae*, both from higher in the McCloud Limestone, have less highly developed lonsdaleoid dissepimentaria as well as other characters that distinguish them from *K. (P.) zulloi.*

K. (P.) zulloi may readily be distinguished from the three species of the subgenus from Nevada, *K. (P.) illipahensis, K. (P.) arcturusensis,* and *K. (P.) nevadensis* by its simpler axial structure.

Etymology. The species is named for Dr. Victor A. Zullo.

Genus *Langenheimia* n. gen.

Diagnosis. *Langenheimia* is a cerioid rugose coral with large corallites, no fossula, septa of two orders, well-defined aulophylloid axial structure, thin and complete wall, tabellae of two ranks—axial and periaxial, the former sloping steeply inwards and upwards, the latter variously inclined but generally gently inwards and upwards to the axial tabellae.

Type Species. *Langenheimia klamathensis* n. sp.

Description. As for the type and only known species.

Discussion. *Langenheimia* has some characters in common with other Permian cerioid rugose corals, but they have the following, among other, important characters that distinguish them from *Langenheimia. Wentzelella* Grabau in Huang, 1932, *Wentzelloides* Yabe and Minato, 1944, and *Wentzelophyllum* Hudson, 1958, all have tertiary septa. *Yokoyamaella* Minato and Kato, 1965a, has thick mural septa. *Ipciphyllum* Hudson, 1958, and *Kleopatrina* McCutcheon and Wilson, 1963, both have clisiophylloid axial structures. *Parawentzelella* Fontaine, 1961, also has a clisiophylloid axial strueture as well as the controversial "canals" between walls of corallites.

Etymology. The genus is named for Dr. Ralph L. Langenheim, Jr.

Langenheimia klamathensis n. sp.

Figures 37f; 38a–b

Diagnosis. Because the genus *Langenheimia* is erected as monotypic, the diagnoses of the genus and of the type species are identical.

External Description. Corallum cerioid, hemispheroidal; maximum observed diameter 13 cm; calyx and epitheca not seen.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 15 to 27 mm wide at greatest diameters; septa of 2 orders, 23 to 27 each; major septa 3.5 to 8.5 mm long, extending into tabularium 3 to 3.5 mm, thin in dissepimentarium, dilate and lanceolate in tabularium, maximum width about 0.5 mm near base in tabularium; minor septa thin, 2 to 3.5 mm long, generally confined to dissepimentarium, rarely penetrating slightly into tabularium; axial structure aulophylloid, of numerous irregular cystose tabellae, elongate, 4 to 5 mm long, 2 to 2.5 mm wide, not touched by septa; dissepiments variously angulo-concentric, concentric, herringbone, or pseudoherringbone, with irregular small dissepiments near bases of some septa; corallite wall entire, thin, about 0.13 mm wide.

Longitudinal Section Description. Dissepimentarium wide, of 5 to 10 ranks of small, cystose to large, elongate, steeply dipping dissepiments; tabellae of 2 series, axial and periaxial; axial tabellae small and cystose to larger and elongate, in 3 to 8 ranks each side, steeply inclined inwards and upwards; periaxial tabellae straight, domed, or sagging, in 1 to 3 ranks, variously inclined gently inwards and upwards (generally), horizontal (uncommon), or inwards and downwards (uncommon) to axial tabellae.

Documentation. UCMP holotype 37231, UCMP paratype 37232. Three thin sections and 30 polished sections from two coralla from UCMP locality D-845 were studied.

Discussion. This coral is the only species that presently seems to be referable to the genus. It does not appear to be comparable to any other described Upper Paleozoic coral. A poorly preserved corallum from UCMP locality A-7096 in the Bayha section of the McCloud Limestone may belong to the same genus and species, but detailed observation of morphological characters is impossible due to metamorphism and styolitic resorption of parts of the corallite.

I have interpreted the longtudinal section as showing two series of tabellae, each consisting of several ranks. The tabellae of the periaxial series are so variously inclined that there might be considered to be three series of tabellae in some parts of the section, but this is not a consistent feature.

Etymology. The species is named for the Klamath Mountains.

Genus *Petalaxis* Milne Edwards and Haime, 1852

Petalaxis allisonae n. sp.

Figures 39a–b

Diagnosis. A species of *Petalaxis* characterized by the combination of small corallites, a moderately large number of major

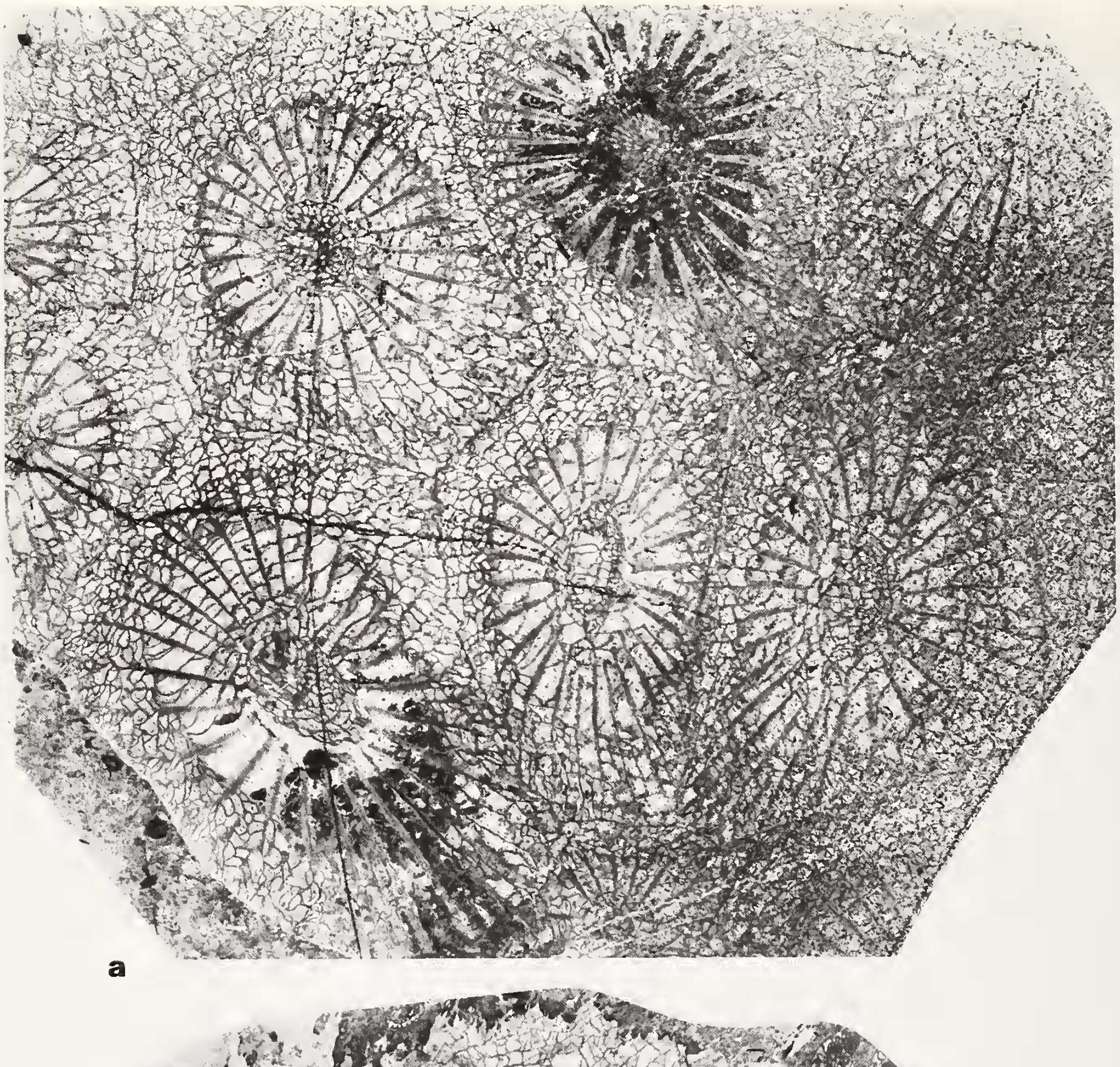


Figure 38. *Langenheimia klamathensis* n. gen., n. sp. Both parts x3. **Part a,** UCMP holotype 37231, transverse section. **Part b,** UCMP paratype 37232, transverse section.

septa, a very dilate columella, and a moderately broad dissepimentarium with few septal spines. It has smaller corallites, fewer major septa, and a somewhat more dilate columella than *P. besti* n. sp. It has smaller corallites and a somewhat less dilate columella than *P. kennedyi* n. sp. It has smaller corallites, a more dilate columella, and a narrower dissepimentarium than *P. pecki* n. sp. It has somewhat smaller corallites, a more dilate columella, and a broader dissepimentarium with fewer septal spines than *P. sutherlandi* n. sp. It has a more dilate columella than *P. brokawi, P. mokomokensis, P. dilatata,* and *P. occidentalis.*

External Description. Corallum cerioid, maximum observed diameter 5 cm; calyx 3 to 4 mm deep, with steeply sloping walls, small central axial boss.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 6 to 7.5 mm wide at greatest diameter; septa of 2 orders, 13 to 16 each, fewer minor septa where lonsdaleoid, thin in dissepimentarium, slightly dilate in tabularium; major septa 1 to 2 mm long, extending into tabularium about 1 mm where dissepimentarium lonsdaleoid, generally absent or represented by septal spines on dissepiments; minor septa fewer than major septa in most corallites, extending slightly into tabularium in places; axial structure a columella, generally lenticular, with smooth edges, attached to counter septum, rarely to cardinal septum also, touched by other septa in some corallites; dissepiments lonsdaleoid, generally inflated, many bearing septal spines, forming false wall separating dissepimentarium and tabularium; corallite wall denticulate, about 0.2 mm wide, generally without septal spines where dissepiments highly inflated.

Longitudinal Section Description. Dissepimentarium of 1 to 3 ranks of steeply dipping, somewhat inflated dissepiments; tabulae generally flat and horizontal, some sloping gently inwards and upwards to columella, some sagging, in places broken up into tabellae, with outer series mostly flat and horizontal, inner series gently inclined inwards and upwards or even tent-shaped (rare); columella slightly sinuous, 0.2 to 0.4 mm wide.

Documentation. Holotype UCMP 37233. Two thin sections and 10 polished sections from one corallum from UCMP locality D-803 were studied.

Discussion. *Petalaxis* presently is distinguished by the possession of predominately flat and horizontal tabulae from *Acrocyathus* d'Orbigny, 1849 (a senior synonym of *Lithostrotionella* Yabe and Hayasaka, 1915, according to Easton, 1973), which generally has tent-shaped tabulae (Sutherland, 1977). Although there is considerable variation in the shape and inclination of tabulae in the McCloud Limestone species of *Petalaxis,* many are flat and horizontal, but few are tent-shaped. Some tabulae of the McCloud specimens even sag deeply, which is unlike the type species of either *Petalaxis* or *Acrocyathus.*

Four species from the Permian of North America may be referred to *Petalaxis: P. brokawi* (Wilson and Langenheim, 1962), Nevada; *P. dilatata* (Easton, 1960), Nevada; *P. mokomokensis* (Easton, 1960), Nevada; *P. occidentalis* (Merriam, 1942), Oregon.

In addition, unfigured paratypes nos. 6 and 7 (USNM nos. 174371 and 174373) of *Lithostrotionella americana* Hayasaka, 1936, likely are from the McCloud Limestone exposures south of the Pit River and might be referrable to *Petalaxis.* I have not seen them. The holotype of *L. americana* is from the Mississippian of Kentucky, and it is improbable that the California Permian paratypes are placed correctly in the same species under current concepts.

P. allisonae does not closely resemble any of the four Permian species listed above, all of which occur in somewhat younger rocks. It is superficially similar, in some characters, to *P. besti* n. sp. and *P. kennedyi* n. sp. from higher in the formation at Hirz Mountain and Potter Ridge, respectively. These two species, however, have larger corallites, more highly denticulate walls, and generally more septa, which are more withdrawn from the columella.

P. allisonae is the lowest record for the genus in the McCloud Limestone.

Etymology. The species is named for Dr. Carol W. Allison.

Petalaxis besti n. sp.

Figures 39c–f

Diagnosis. A species of *Petalaxis* characterized by the combination of large corallites, a great number of major septa, a lenticular columella, and a very broad dissepimentarium with few septal spines. By the large number of septa alone, it can be distinguished from *P. allisonae, P. kennedyi* n. sp., *P. pecki* n. sp., *P. sutherlandi* n. sp., *P. brokawi, P. mokomokensis, P. dilatata,* and *P. occidentalis.*

External Description. Corallum cerioid, maximum observed diameter 8 cm; external features not preserved.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 7 to 11 mm wide; septa of 2 orders, 17 to 21 each, thin in dissepimentarium and tabularium; major septa 1 to 2 mm long, extending into tabularium 1 to 1.5 mm; minor septa generally represented by spines on inner wall, dissepiments, and outer wall; axial structure a columella, roughly lenticular, with sinuous edges and, in places, 1 or 2 septal lamellae, generally attached to counter septum, not touched by other septa; dissepimentarium lonsdaleoid except in immature corallites, with large dissepiments, some with septal spines; corallite wall highly denticulate, about 0.5 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 (rarely 2) ranks of steeply dipping, inflated dissepiments; tabulae variably inclined: flat and horizontal to sinuous and sloping downwards and inwards to columella, but generally flat and horizontal near columella; columella only slightly sinuous, 0.3 to 0.9 mm wide.

Documentation. UCMP holotype 37234, UCMP paratypes 37235–37237. Four thin sections and 54 polished sections from four coralla from UCMP localities D-857 (three paratypes) and D-858 (holotype) were studied.

Discussion. This species can be distinguished readily from others in the genus from the McCloud Limestone by its greater number of septa, as well as other features. *P. occidentalis*, from

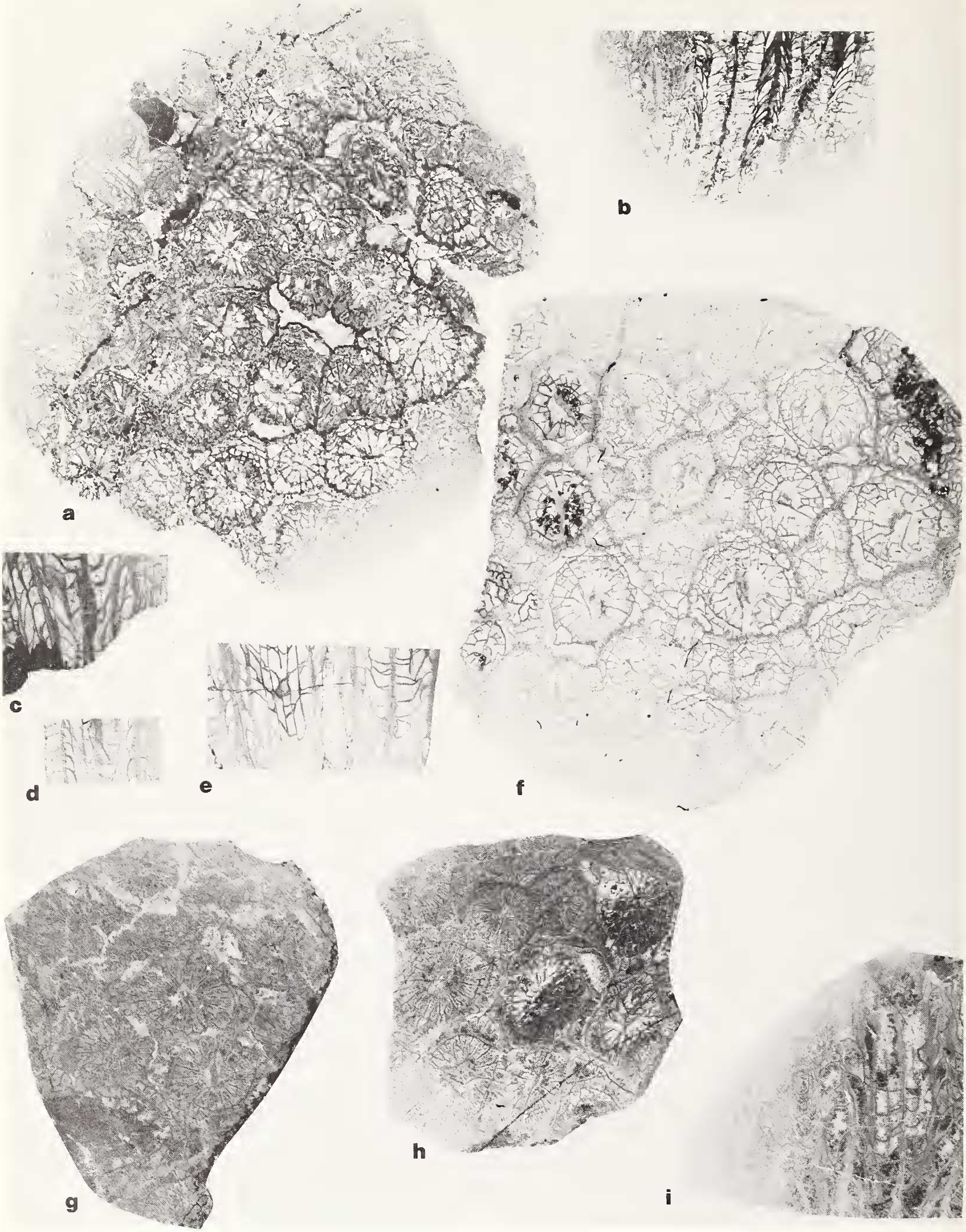


Figure 39. *Petalaxis allisonae* n. sp., *P. besti* n. sp., and *P. kennedyi* n. sp. All parts x3.

Parts a and b. *P. allisonae* n. sp., UCMP holotype 37233, transverse (a) and longitudinal (b) sections.

Parts c through f. *P. besti* n. sp., UCMP holotype 37234, longitudinal (c–e) and transverse (f) sections.

Parts g through i. *P. kennedyi* n. sp., UCMP holotype 37238, transverse (g, h) and longitudinal (i) sections.

the Permian of Oregon, has smaller corallites and fewer septa than *P. besti*.

Etymology. The species is named for Dr. R.V. Best.

Petalaxis kennedyi n. sp.

Figures 39g–i

Diagnosis. A species of *Petalaxis* characterized by the combination of large corallites, a moderately great number of major septa, a highly dilate (most circular in transverse section) columella, and a moderately broad dissepimentarium with few septal spines. It has somewhat larger corallites and a somewhat more dilate columella than *P. allisonae*. It has a much more dilate columella than *P. besti*, *P. pecki* n. sp., *P. sutherlandi* n. sp., *P. brokawi*, *P. mokomokensis*, *P. dilatata*, and *P. occidentalis*.

External Description. Corallum cerioid, maximum observed diameter 13 cm; calices and wall not observed.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 4 to 10 mm wide at greatest diameter; septa of 2 orders, 14 to 17 each, thin throughout or slightly dilate in tabularium; major septa 1.5 to 2.5 mm long, extending into tabularium 0.2 to 0.4 mm; axial structure a dilate, lenticular columella, generally smooth edged, attached to counter septum (rarely to cardinal septum also); dissepiments lonsdaleoid, large, some with septal spines; corallite wall denticulate, with long septal spines in places, 0.3 to 0.6 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 (rarely 2–3) ranks of steeply dipping, very highly inflated dissepiments; tabulae generally flat and horizontal or sloping downwards and inwards, turning up slightly at columella, rarely inwards and upwards; columella straight, about 0.3 mm wide.

Documentation. UCMP holotype 37238, UCMP paratypes 37239–37241, LACMIP paratype 6424. Five thin sections and 76 polished sections from five coralla from UCMP localities D-836 (holotype 37238), D-837 (paratypes 37239–37240), and D-841 (paratype 37241) and LACMIP locality 1116 (paratype 6424) were studied.

Discussion. *P. kennedyi* has similar corallite diameters and numbers of septa to *P. allisonae*, but the latter has much longer septa and many more ranks of dissepiments. *P. besti* n. sp. has a greater number of septa, a thicker wall, and a narrower dissepimentarium than *P. kennedyi*. The other two McCloud Limestone new species of this genus also are from Potter Ridge, but they have much more dilate columellae than *P. kennedyi*. The species is dissimilar in many ways to the other species already known from the Permian of Oregon and Nevada.

Etymology. The species is named for Dr. George L. Kennedy.

Petalaxis pecki n. sp.

Figures 40a–e

Diagnosis. A species of *Petalaxis* characterized by the combination of large corallites, a moderately great number of major septa, a lenticular columella, and a narrow dissepimentarium with many septal spines. It has a thinner columella than *P. allisonae* and *P. kennedyi*. It has a smaller number of septa and a narrower dissepimentarium with more septal spines than *P. besti*. It has a somewhat greater number of septa and a broader dissepimentarium with fewer septal spines than *P. sutherlandi* n. sp.

External Description. Corallum cerioid, maximum observed diameter 8 cm; calices and wall not observed.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 5.5 to 10 mm wide at greatest diameter; septa of 2 orders, 12 to 17 each, thin, generally absent in dissepimentaria of adult corallites; major septa 0.5 to 1.0 mm long; minor septa well developed, about 0.2 mm long; axial structure a columella (stereocolumella) somewhat lenticular, smooth-edged, maximum observed size about 0.6 mm wide, 1.0 mm long, attached to counter septum, rarely to other septa; dissepiments lonsdaleoid, inflated, some with septal spines; corallite wall denticulate, generally without septal spines in adult corallites, 0.2 to 0.3 mm wide.

Longitudinal Section Description. Dissepimentarium of 1 to 3 ranks of elongate, steeply dipping, inflated dissepiments; tabulae slope steeply downwards and inwards to columella, becoming flat near junction or turning up slightly at columella, breaking down into tabellae in places, with outer series like clinotabellae; columella essentially straight, 0.5 to 0.9 mm wide.

Documentation. UCMP holotype 37242, UCMP paratypes 37243–37245. Seven thin sections and 40 polished sections from four coralla from UCMP localities D-842 (holotype 37242, paratype 37243) and D-843 (paratypes 37244–37245) were studied.

Discussion. *P. pecki* has a thicker columella (stereocolumella) than any other species of the genus from the McCloud Limestone except *P. sutherlandi* n. sp. The latter species may be distinguished by its thicker columella, generally thinner walls, septa, and dissepiments, and more open dissepimentarium as seen in transverse section. *P. occidentalis* from the Permian Coyote Butte Formation of Oregon is similar to *P. pecki* in corallite size, septal number, dilation of columella, and inclination of tabulae/tabellae, but it has a thicker wall, septa closer to the columella, and a false wall in contact with the corallite wall in more places. *P. pecki* is not similar to other Permian North American species of the genus.

Etymology. The species is named for Mr. Joseph H. Peck, Jr.

Petalaxis sutherlandi n. sp.

Figures 40f–i

Diagnosis. A species of *Petalaxis* characterized by the combination of moderately large corallites, a moderately great number of major septa, a lenticular columella, and a narrow dissepimentarium with many septal spines. It has somewhat larger corallites, a thinner columella, and a narrower dissepimentarium with more septal spines than *P. allisonae*. It has somewhat smaller corallites, fewer septa, and a narrower dissepimentarium with more septal spines than *P. besti*. It has a thinner columella and a narrower dissepimentarium with more septal spines than *P. kennedyi*. It has somewhat fewer septa and a narrower dissepimentarium with more septal spines than *P. pecki*. It has a narrower dissepimentarium and a generally more lenticular columella than *P. brokawi*, *P. mokomokensis*, *P. dilatata*, and *P. occidentalis*.

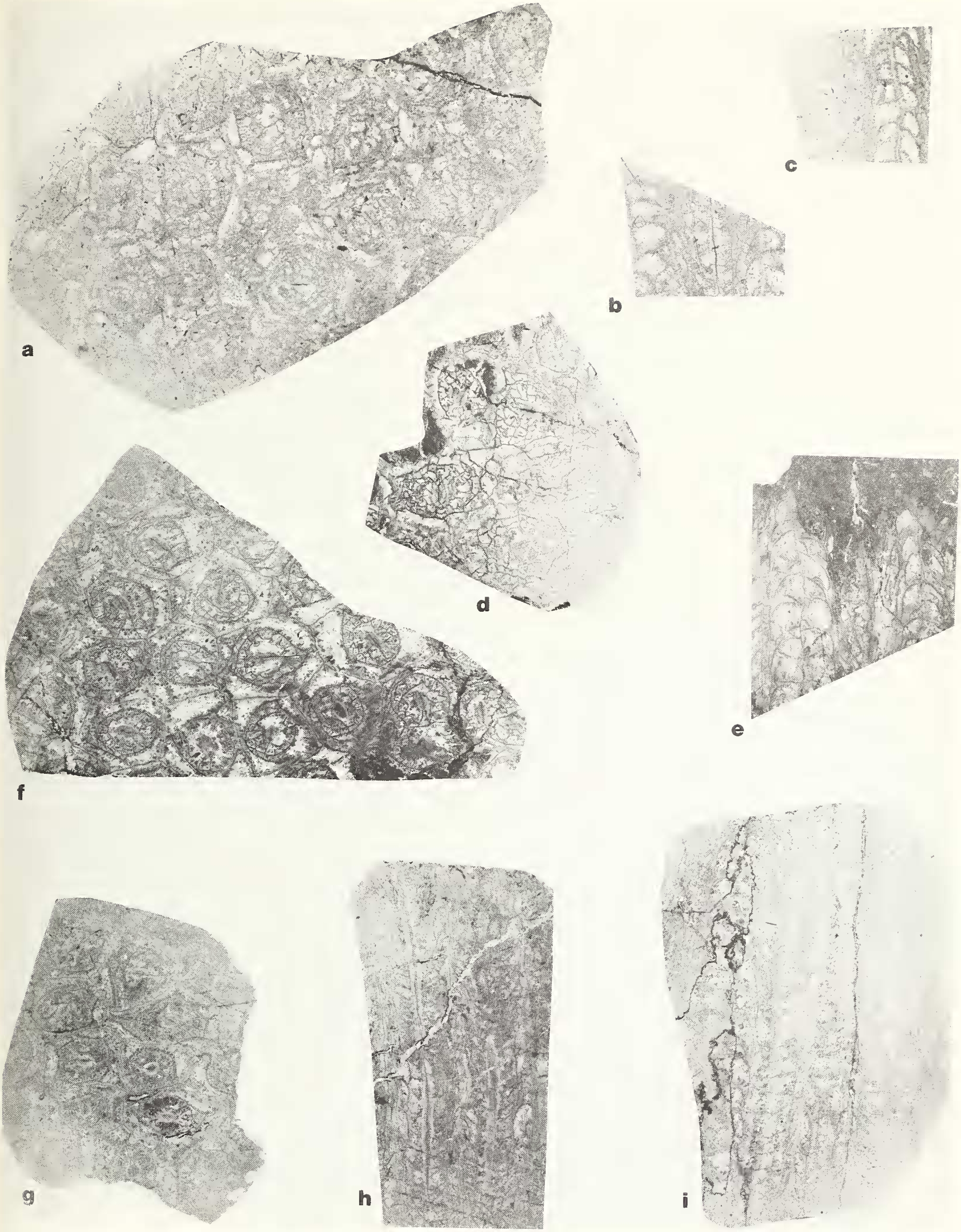
External Description. Corallum cerioid, maximum observed diameter 8 cm; external features not preserved.

Transverse Section Description. Corallites polygonal, 5 to 7 sided,

Figure 40. *Petalaxis pecki* n. sp. and *P. sutherlandi* n. sp. All parts x3.

Parts a through e. *P. pecki* n. sp. **Parts a through c,** UCMP holotype 37242, transverse (a) and longitudinal (b, c) sections. **Parts d and e,** UCMP paratype 37244, transverse (d) and longitudinal (e) sections.

Parts f through i. *P. sutherlandi* n. sp. **Parts f and i,** UCMP holotype 37246, transverse (f) and longitudinal (i) sections. **Parts g and h,** UCMP paratype 37247, transverse (g) and longitudinal (h) sections.


a
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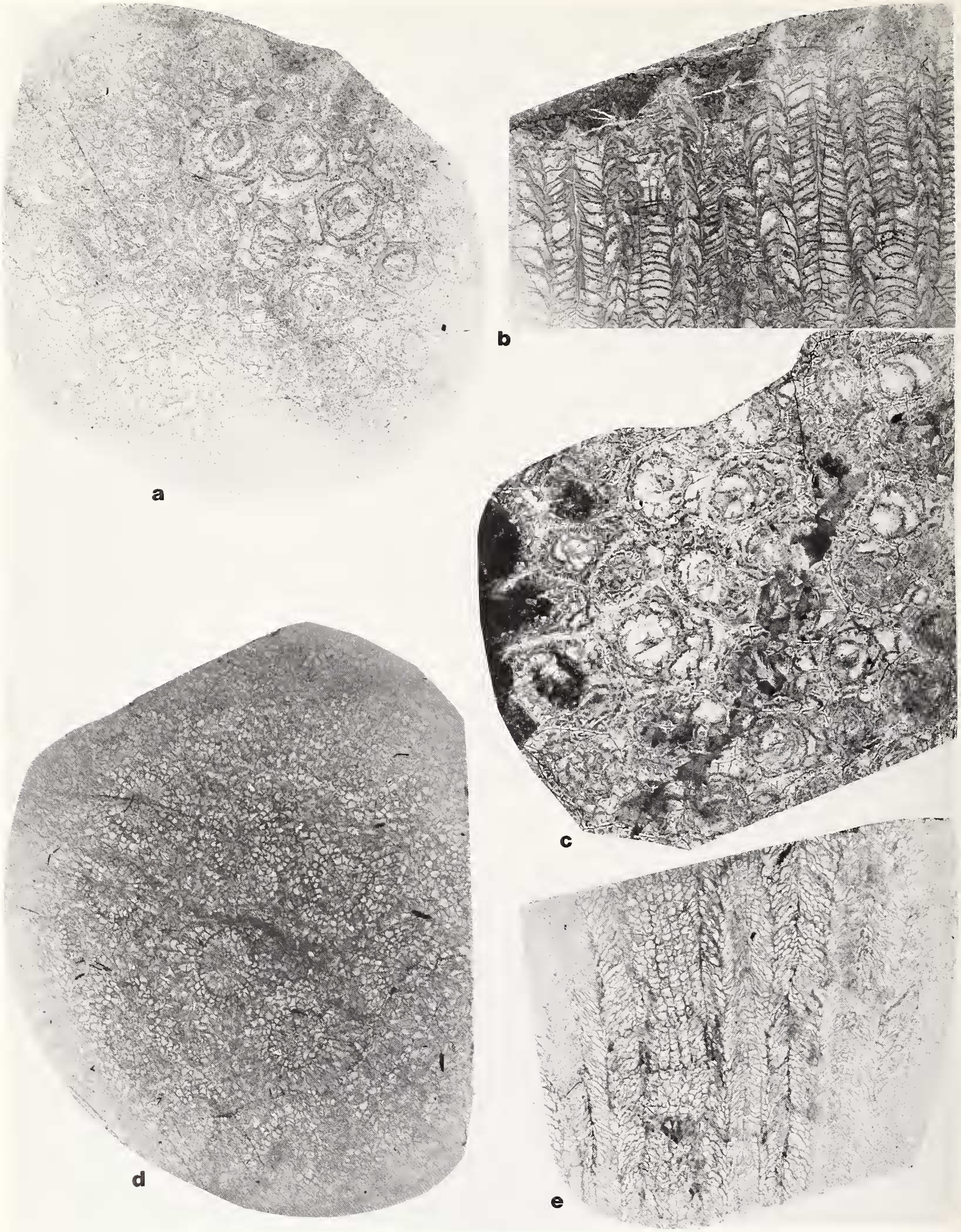


Figure 41. *Traskina shastensis* n. gen., n. sp. and *Arachnastraea fryi* n. sp. All parts x3.

Parts a through c. *T. shastensis* n. gen., n. sp. **Parts a and b,** UCMP holotype 37253, transverse (a) and longitudinal (b) sections. **Part c,** UCMP paratype 37254, transverse section.

Parts d and e. *A. fryi* n. sp., UCMP holotype 37256, transverse (d) and longitudinal (e) sections.

4 to 9 mm wide at greatest diameter; septa of 2 orders, with most corallites having fewer minor than major septa; major septa 12 to 15 in number, 0.4 to 1.0 mm long, generally present only in tabularium, in places represented by septal spines on corallite wall or dissepiments, thin throughout; minor septa short septal spines in tabularium, absent or reduced in number in some corallites, in places represented by septal spines on corallite wall and dissepiments; axial structure a columella (stereocolumella), round or somewhat oval, generally smooth edged, maximum observed size about 0.7 mm wide, 1.5 mm long, attached to counter septum, very rarely in contact with other septa; dissepiments very large, so few in each corallite that dissepimentarium appears nearly "empty"; corallite wall thin, sinuous, apparently vestigially denticulate, about 0.2 mm wide, with septal spines in few places.

Longitudinal Section Description. Dissepimentarium of 1 row of inflated, very steeply inclined dissepiments, 8 to 9 per cm; tabulae generally straight, sloping gently downwards and inwards toward columella, rarely sigmoid and sloping steeply down (clinotabellae-like); columella straight or slightly sinuous, maximum observed diameter 0.9 mm.

Documentation. UCMP holotype 37246, UCMP paratypes 37247–37252. Four thin sections and 76 polished sections from seven coralla from UCMP locality D-845 were studied.

Discussion. This species probably is related to *P. pecki*, which occurs lower in the same section. Differences are discussed under *P. pecki*. *P. sutherlandi* is not otherwise similar to other species of *Petalaxis* from the Permian of North America.

Etymology. The species is named for Dr. Patrick K. Sutherland.

Genus *Traskina* n. gen.

Diagnosis. *Traskina* is a sciophylloid cerioid rugose coral with two orders of intermittently developed septa, simplified clisiophylloid axial structure of straight to sinuous medial plate and few sinuous septal lamellae, highly lonsdaleoid dissepimentarium, complete denticulate wall, tabulae sloping inwards and upwards to medial plate, rarely separated into irregular axial and periaxial tabellae with similar inclination.

Type Species. *Traskina shastensis* n. sp.

Description. As for the type and only known species.

Discussion. *Traskina* is superficially similar to *Kleopatrina (Porfirievella)* Minato and Kato, 1965b, but differs by having only vestigial septa (where developed at all), well-developed tabulae, and, in places, poorly zoned tabellae whereas the latter taxon has strongly developed septa and two well-defined zones of tabellae. The axial structures of *Traskina* are a medial plate and septal lamellae, both of which are generally sinuous (even zigzag in places), whereas the same structures of *Kleopatrina* are more nearly straight. Finally, all the skeletal elements of *Traskina* are the thin sciophylloid kind whereas those of *Kleopatrina* are robust.

Traskina has vestigial septa and thin skeletal elements similar to *Sciophyllum* Harker and McLaren, 1950, known from the Upper Mississippian (?) near the Yukon-Alaska boundary, the Lower Pennsylvanian of Japan, and the Lower Permian of east-central Nevada (Wilson and Langenheim, 1962:514) and possibly the Pennsylvanian and Lower Permian of the Ural Mountains, Russia (as *Thysanophyllum aseptatum* Dobrolyubova, 1936). However, *Traskina* has an axial structure and *Sciophyllum* has none.

Etymology. The genus is named for Dr. John B. Trask.

Traskina shastensis n. sp.

Figures 41a–c

Diagnosis. Because the genus *Traskina* is erected as monotypic, the diagnoses of the genus and of the type species are identical.

External Description. Corallum cerioid, maximum observed diameter 10 cm; calices and epitheca not seen.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 5.5 to 8 mm wide at greatest diameter; septa of 2 orders; major septa number 13 to 15 where well developed (rare), generally numbering fewer than 10, conspicuously absent in parts of most corallites, total length 0.4 to 1.0 mm, extending into tabularium 0.2 to 0.5 mm, generally present as spines on corallite wall and false wall; minor septa rare, present as septal spines, absent in tabularium; axial structure clisiophylloid, of straight (uncommon), sinuous, or zigzag, thin or somewhat dilate medial plate crossed by 1 to 4 sinuous or zigzag septal lamellae, with medial plate rarely attached to counter septum; dissepiments highly lonsdaleoid, not discernible in many corallites, so that dissepimentarium appears nearly structureless; corallite wall 0.1 to 0.2 mm thick, straight or somewhat denticulate, with septa originating from V-shaped depressions.

Longitudinal Section Description. Dissepimentarium of 1 to 2 ranks of highly inflated, steeply dipping, cystose dissepiments; tabulae straight or slightly domed, with straight or slightly downturned peripheral ends, sloping gently inwards and upwards to columella, 18 to 20 per cm, rarely broken down into tabellae; columella straight to somewhat sinuous.

Documentation. UCMP holotype 37253, UCMP paratype 37254. Five thin sections and 42 polished sections from two coralla from UCMP locality D-843 were studied.

Discussion. There does not seem to be any described species that should be placed in *Traskina* with the type species.

Etymology. The species is named for Shasta Lake.

Cerioid-Astreoid Rugosa

Genus *Arachnastraea* Yabe and Hayasaka, 1916

Arachnastraea fergusoni n. sp.

Figures 42a–e

Diagnosis. A species of *Arachnastraea* characterized by the combination of very large corallites, well-developed and relatively long minor septa, and a complex axial structure. It has larger corallites, better developed minor septa, and a more complex axial structure than *A. fryi* n. sp., *A. molli*, and *A. manchurica*.

External Description. Corallum cerioid-astreoid; maximum observed diameter 11.5 cm; calices deep with prominent axial boss; external features not well preserved.

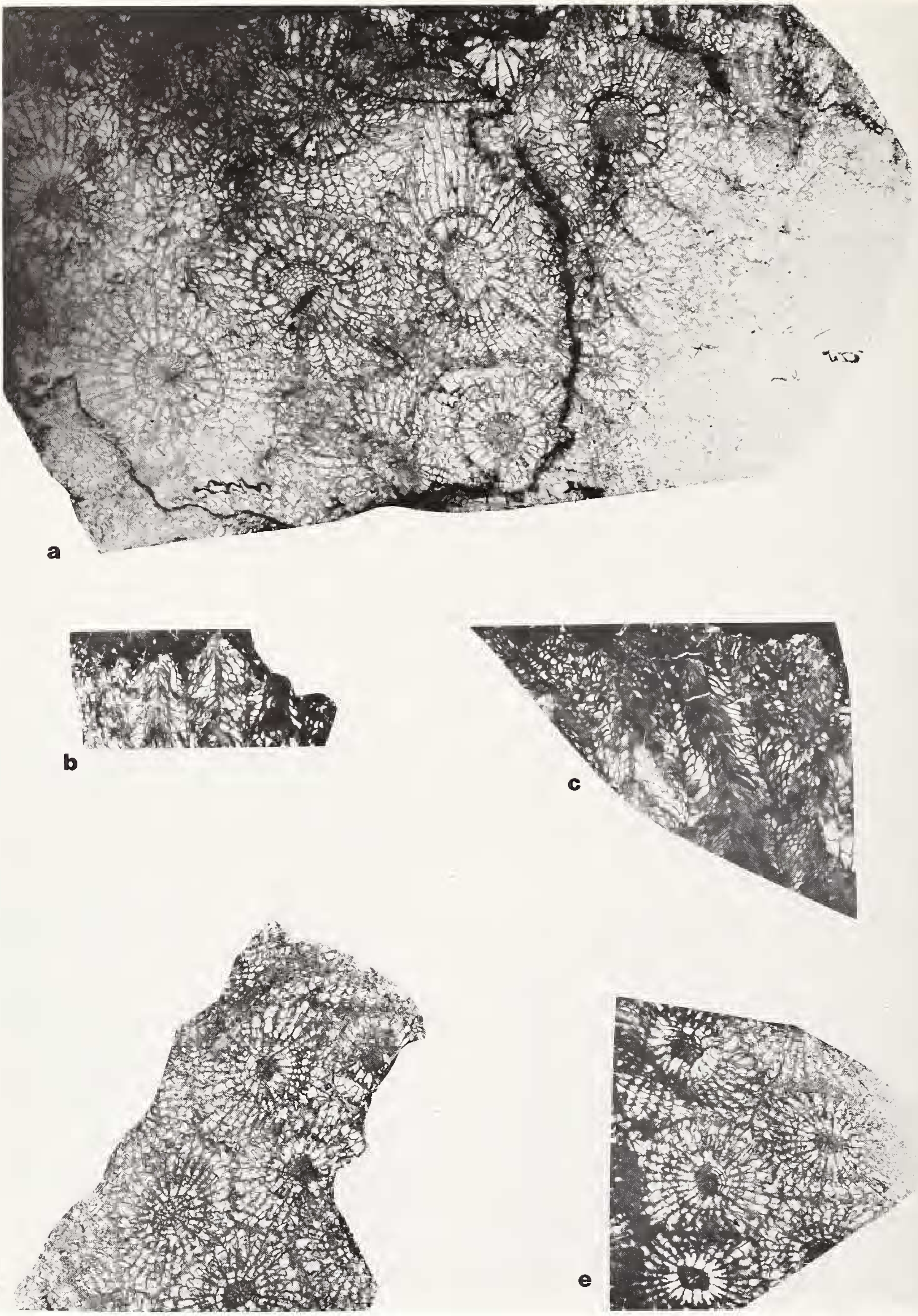


Figure 42. *Arachnastraea fergusoni* n. sp. All parts x3. **Parts a through c,** LACMIP holotype 6425, transverse (a) and longitudinal (b, c) sections. **Parts d and e,** UCMP paratype 37255, transverse sections.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 10 to 16 mm wide at greatest diameter; septa of 2 orders, 16 to 18 each; major septa 2.5 to 5 mm long, extending into tabularium 0.5 to 1.5 mm, generally slightly dilate in tabularium, most touching axial structure but not confluent with axial tabellae; minor septa well developed, extending across dissepimentarium and penetrating tabularium as dilate spines; axial structure arachnoid, circular, 2 to 3.5 mm wide, generally symmetrical, with well-developed medial plate and septal number equal to or greater than number of septa, tightly connected by tabellae; dissepimentarium regular; dissepiments straight, angulo-concentric, or pseudoherringbone; corallite wall cerioid-astreoid, very discontinuous, about 0.3 mm wide.

Longitudinal Section Description. Dissepimentarium of 3 to 6 ranks, various sized cystoid or elongate, gently dipping dissepiments, about 22 per cm; tabellae of 2 well-defined ranks, axial and periaxial; axial tabellae elongate, of 2 to 4 steeply dipping ranks, 38 to 40 per cm; periaxial tabellae straight, slightly domed with downturned edges, gently dipping, 20 to 28 per cm; wall about 0.2 mm wide where present.

Documentation. LACMIP holotype 6425, UCMP paratype 37255. Five thin sections and 29 polished sections from two coralla from LACMIP locality 1125 (holotype 6425) and UCMP locality D-852 (paratype 37255) were studied.

Discussion. The UCMP paratype of *A. fergusoni* is a small corallum (4 cm diameter) and has smaller corallites (diameter 6 to 10 mm) and slightly fewer major septa (13 to 16) than the holotype. I consider it to be a juvenile corallum, although the possibilities exist that it may belong to another species or represent variation within the species. Both coralla were closely associated in the same bed.

A. fryi n. sp. from the Potter Ridge section of the McCloud Limestone has smaller corallites, a more continuous wall, and a less complex axial structure than *A. fergusoni*. *A. molli* (Stuckenberg, 1888) from the Middle Carboniferous of Russia and *A. manchurica* Yabe and Hayasaka, 1916 (the type species), from the Lower Permian (?) of Manchuria have smaller corallites (diameter 6 to 8 mm), simpler axial structures, septa more continuous with the axial lamellae, and less well-developed minor septa.

This is the first record for the genus in the Americas.

Etymology. The species is named for Mr. Eugene Ferguson.

Arachnastraea fryi n. sp.

Figures 41d–e

Diagnosis. A species of *Arachnastraea* characterized by the combination of moderately large corallites, well-developed minor septa, and a moderately complex axial structure. It has smaller corallites, somewhat shorter minor septa, and a somewhat less complex axial structure than *A. fergusoni*. It has larger corallites, a more complex axial structure, and better developed minor septa than *A. molli* and *A. manchurica*.

External Description. Corallum cerioid-astreoid, maximum observed diameter 12 cm; calyx not observed.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 6.5 to 10 mm wide at greatest diameter; septa of 2 orders, 15 to 17 each; major septa 2.5 to 3.5 mm long, extending into tabularium 0.5 to 1.0 mm, thin throughout or slightly dilate in tabularium, generally connected with septal lamellae of axial structure; minor septa well developed, extending across dissepimentarium and barely penetrating tabularium; axial structure arachnoid, with thin, well-developed medial plate, septal lamellae generally equal in number to and confluent with major septa; dissepimentarium regular; dissepiments straight, concentric, angulo-concentric, or pseudoherringbone; corallite wall cerioid-astreoid, about 0.2 mm thick.

Longitiduinal Section Description. Dissepimentarium of 4 to 6 ranks of gently inclined dissepiments, about 33 per cm; tabellae of 2 ranks, axial and periaxial; axial tabellae sloping either steeply or gently inwards and upwards to columella; periaxial tabellae sloping gently inwards and upwards to axial tabellae; columella slightly sinuous; wall clearly shows interruptions.

Documentation. UCMP holotype 37256. Two thin sections and 12 polished sections from one corallum from UCMP locality D-837 were studied.

Discussion. In several features, *Arachnastraea fryi* appears to be close to *A. molli* from the Middle Carboniferous of Russia, as figured by Hill (1956, figs. 194, 3a, 3d) and Soshkina, Dobrolyubova, and Kabakovich (1962:343, figs. 106a, 106b). All illustrations show remarkably similar axial structures, partially dilate septa, and denticulate walls, where present. The specimen figured by Hill shows corallites with as many as 21 major septa and apparently no minor septa, whereas that of Soshkina, *Dobrolyubova*, and Kabakovich has well-developed minor septa and major septa numbering about 14. They may represent different species.

Because it has fewer septa and well-developed minor septa, *A. fryi* is not specifically close to the specimen of *A. molli* figured by Hill. The specimen figured by Soshkina, Dobrolyubova, and Kabakovich has somewhat fewer septa than *A. fryi*, but their *A. molli* has septa that are dilate in the dissepimentarium of some corallites. *A. fryi* has no dilate septa in the dissepimentarium and its dissepimentarium is much wider than that shown in the Soshkina, Dobrolyubova, and Kabakovich illustrations.

Differences with *A. fergusoni* n. sp. also from the McCloud Limestone, are listed in the discussion of that species.

Etymology. The species is named for Dr. Wayne L. Fry.

Order Tabulata Milne Edwards and Haime, 1850

Genus *Bayhaium* Langenheim and McCutcheon, 1959

Bayhaium merriamorum Langenheim and McCutcheon, 1959

Figures 43a–g

Bayhaium merriamorum Langenheim and McCutcheon, 1959: 100, pl. 19, figs. 1–6.

Bayhaium merriamorum Langenheim and McCutcheon. Lafuste, 1963:1127, text-figs. 1–3.

Documentation. UCMP hypotypes 37257-37260. Five thin sections and 14 polished sections from one corallum from UCMP

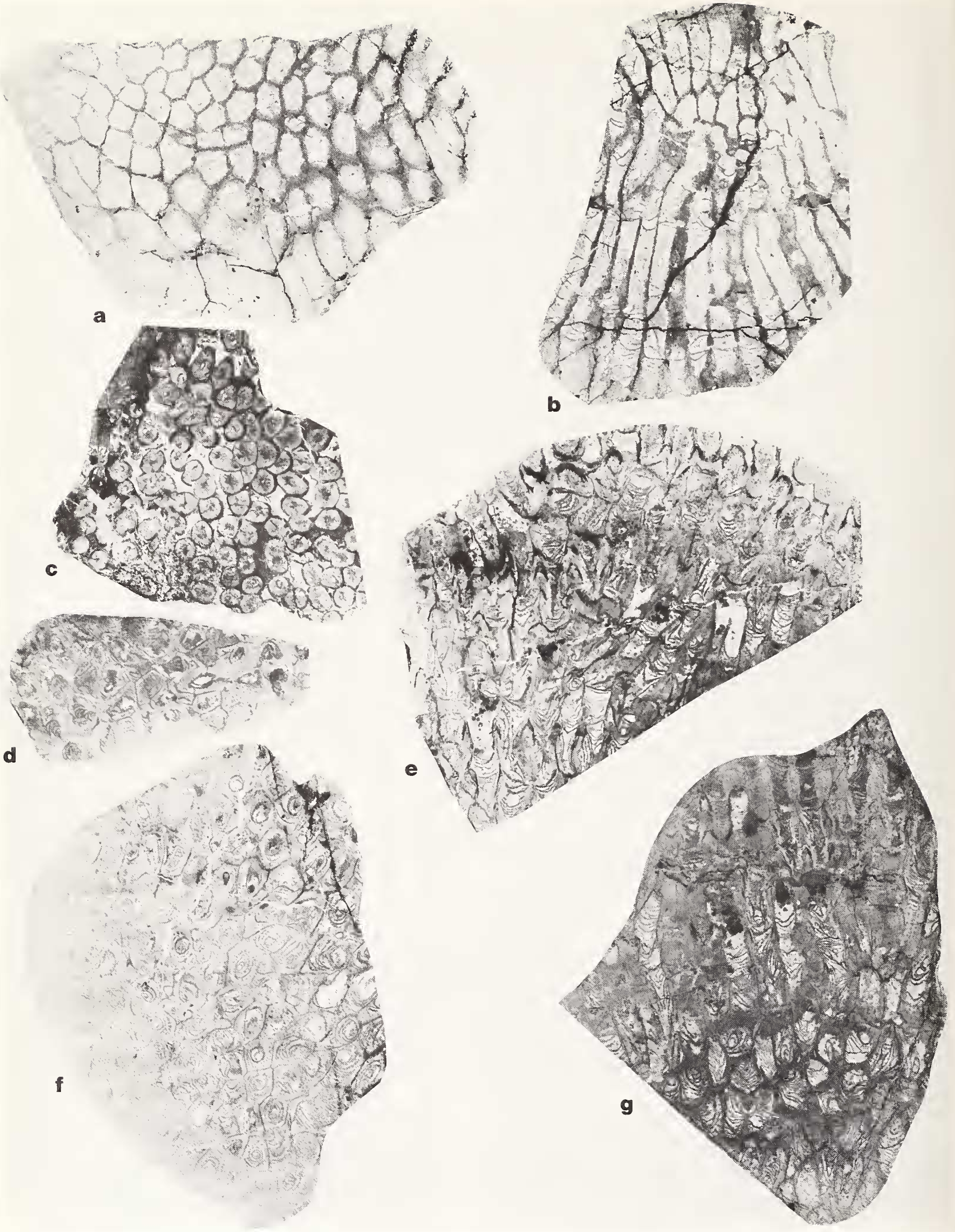


Figure 43. *Bayhaium merriamorum* Langenheim and McCutcheon, 1959. All parts x3. **Parts a and b,** UCMP hypotype 37257, transverse (a) and longitudinal (b) sections. **Part c,** UCMP hypotype 37258, transverse section. **Parts d and e,** UCMP hypotype 37259, transverse (d) and longitudinal (e) sections. **Parts f and g,** UCMP hypotype 37260, transverse (f) and longitudinal (g) sections.

locality D-181 (hypotype 37257), four thin sections and four polished sections from one corallum from UCMP locality D-838 (hypotype 37258), and four thin sections and 21 polished sections from two coralla from UCMP locality D-839 (hypotypes 37259–37260) were studied.

Discussion. Since a very active search was made by me for this coral and I found that it occupied narrow stratigraphic ranges in the Bayha and Potter Ridge sections, I conclude that these occurrences represent a biostratigraphic correlation between the sections and probably the intervening type locality.

Bayhaium virginiae n. sp.

Figures 44a–f

Diagnosis. A species of *Bayhaium* characterized by the combination of thick walls in the immature regions and the rarity of septa and tabulae. It has thicker walls in the immature region and far fewer septa and tabulae than *B. merriamorum.* It has far fewer septa and tabulae than *B. vallum.*

External Description. Corallum cerioid-fasciculate, generally hemispherical, maximum observed diameter 4 cm, outer corallites cylindrical, closely spaced.

Transverse Section Description. In immature portion, corallites cerioid, generally 1 to 1.5 mm in diameter (1 is 2 mm), generally without septa (1 has 3 short septa), with sclerenchyme-thickened walls (generally about 0.3 mm thick on each side of separating dark line, 1 thickened *Multithecopora*-like to 0.9-mm-thick wall and constricted 0.3-mm thick tabularium), with rare infundibuliform tabulae about 0.16 mm thick, no apparent connecting tubules. In mature portion, corallites 1 to 1.5 mm diameter, 0.6 to 1.0 mm apart, with walls 0.3 to 0.5 mm thick.

Longitudinal Section Description. In mature portion, as above, with randomly clumped tabulae, 2 to 4 per mm, generally concave, rarely tabellae or infundibuliform; connecting tubules tunnel-like, rare, randomly scattered, with 0.4- to 0.5-mm wide openings with tabulae passing through; calices as much as 6 mm from top to first tabulae below.

Documentation. UCMP holotype 37261, UCMP paratype 37262. Six thin sections and nine polished sections from two coralla from UCMP locality D-852 were studied.

Discussion. *Bayhaium merriamorum,* the type species of the genus, is known only from the type locality and nearby areas in the McCloud Limestone, which are stratigraphically higher in the formation and south of the locality where *B. virginiae* n. sp. was collected. The latter species has much thicker walls in the immature region, far fewer septa where developed at all, and far fewer tabulae than *B. merriamorum. B. vallum* Hoare, 1964, from the Wolfcampian Sunflower Formation of Elko County, Nevada, is more similar to *B. merriamorum* than to *B. virginiae.* The latter species can be distinguished readily from *B. vallum* by many of the same features that distinguish it from *B. merriamorum,* especially the lack of, or poor development of, septa and tabulae. However, both *B. virginiae* and *B. vallum* have thicker walls in the immature parts of the corallum than has *B. merriamorum.*

This is the third species of *Bayhaium* erected. The genus has been reported only from the Lower Permian (Wolfcampian) Cordilleran eugeosynclinal rocks of California and Nevada.

Etymology. The species is named for Virginia A. McCutcheon Langenheim.

Genus *Enigmalites* Tchudinova, 1975a

Enigmalites roberti n. sp.

Figures 44g–h; 45a–c

Diagnosis. A species of *Enigmalites* characterized by the combination of large corallites, poorly developed septal spines and connecting processes, and relatively abundant dissepiments and tabulae. It has fewer septal spines, fewer connecting processes, and more dissepiments and tabulae than *E. lectus.* It has larger corallites than *E. tschernyschewi, E. lautus,* and *E. largus.*

External Description. Corallum basally reptant, distally erect, phaceloid, irregularly hemispheroidal, maximum observed height 9 cm, width 9 cm (both incomplete); epitheca with coarse rugae; connecting tubules rare.

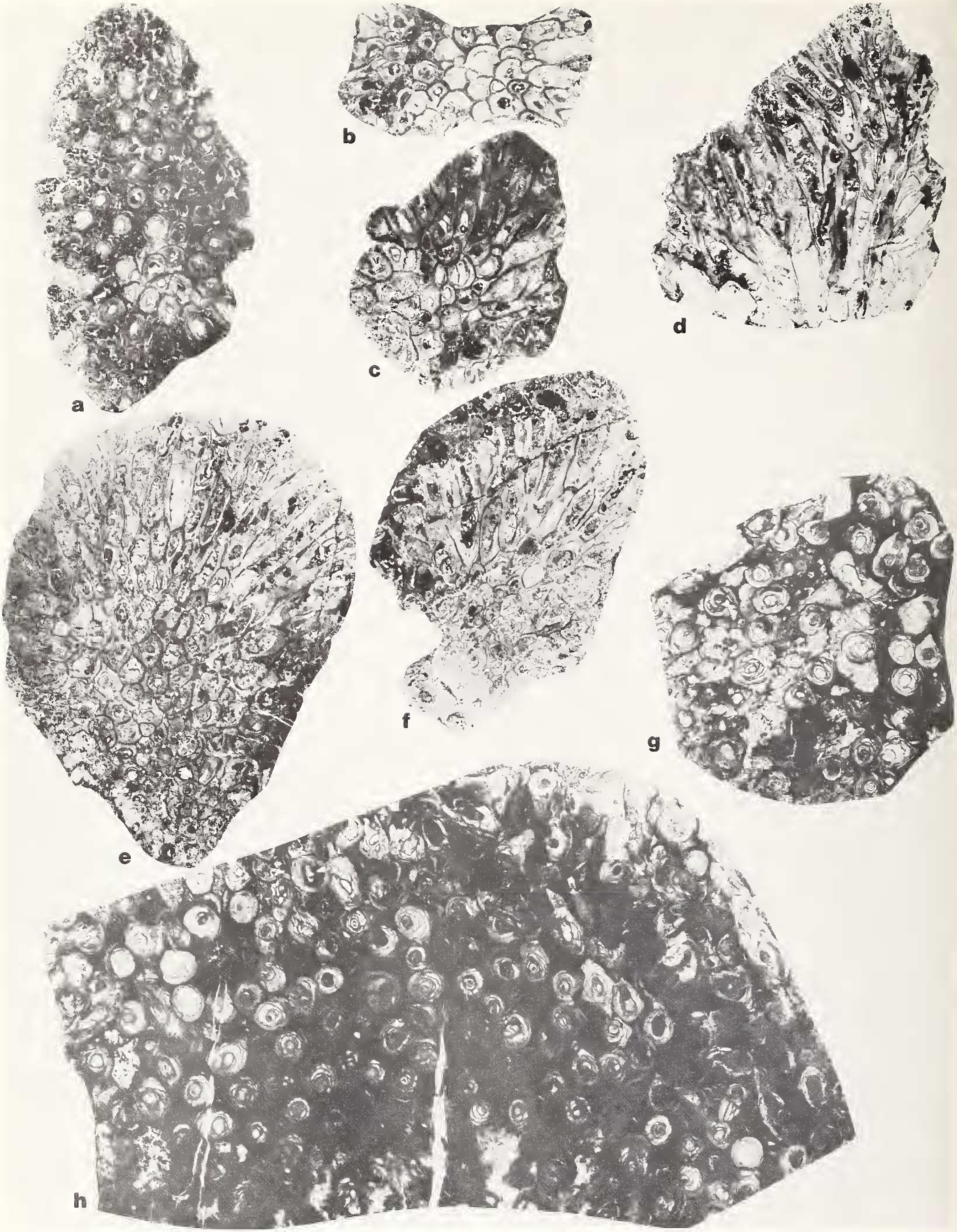
Internal Description. Corallites 2.2 to 2.5 mm in diameter, touching to as much as 1 corallite diameter distant; wall 2-layered, 0.2 to 0.4 mm thick, epitheca microstructure not observed, sclerenchyme layer fibrous, with fibers radially oriented, at right angles to epitheca in transverse and longitudinal sections, not bundled into trabeculae; dissepiments numerous, 1 to 3 ranks, steeply dipping in longitudinal section, circling the interior of the wall in transverse section, leaving central or slightly off-centered tabularium; tabularium open or rarely crossed by flat or slightly domed tabulae; septal spines short, conical, irregularly developed, not present in all corallites, maximum number of 14 where fully developed (rare), generally only a few present on wall, on sclerenchyme, and on dissepiments (lonsdaleoid-like), pointing gently inwards and upwards in longitudinal sections; connecting tubules and mural pores very rare.

Documentation. UCMP holotype 37263, UCMP paratypes 37264–37265. Six thin sections and 57 polished sections from three coralla from UCMP locality A-7101 were studied.

Discussion. Tchudinova (1975a:13) based this genus on a new species and a species of Stuckenberg (1895:19) and later (1975b:429) placed two other new species in it. These specimens were collected in the Ural Mountains. Tchudinova's three species are Lower Permian and Stuckenberg's species is Upper Carboniferous.

The genus is characterized by the combination of an epitheca lined by a thin layer of sclerenchyme, incomplete tabulae taking the form of dissepiments and leaving a tabularium-like central area that is occupied in places by tabulae, septal spines, and rare connecting processes. Probably some species presently placed in *Syringopora* will be assigned by other workers to *Enigmalites. E. roberti* is the first report of the genus outside of Russia.

E. roberti is close to *E. lectus* Tchudinova, 1975a, the type species, in corallite size and thickness of the wall. *E. roberti* has fewer and less well developed septal spines, many present on the dissepiments, rarer connecting processes, more abundant dissepiments, and more tabulae than *E. lectus.* Both *E. roberti* and *E. lectus* have larger corallites than *E. tschernyschewi* (Stucken-


a
b
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h

berg, 1895), *E. lautus* Tchudinova, 1975b, and *E. largus* Tchudinova, 1975b.

Etymology. The species is named for Mr. Robert B. Spangenberg.

Genus *Michelinia* de Koninck, 1841

***Michelinia nelsoni* n. sp.**

Figures 45d–h

Diagnosis. A species of *Michelinia* characterized by the combination of moderately large corallites, lack of mural pores, and presence of generally complete tabulae. It has smaller corallites than *M. branneri*, *M. harkeri*, and *M. referta*. It has larger corallites than *M. eugeneae*, *M. subcylindrica*, and *M. tenuicula*. It has no mural pores such as those present in *M. exilimura*, *M. latebrosa*, *M. scopulosa*, and *M. spissata*.

External Description. Corallum cerioid, small, maximum observed diameter 2.1 cm, roughly hemispherical, covered ventrally by wrinkled corallite wall; calices 3.5 to 4.5 mm wide, 2 to 5 mm deep, with flat floors and smooth, slightly flaring walls.

Transverse Section Description. Corallites polygonal, 5 to 7 sided, 3.5 to 4.5 mm wide; mural pores not observed, apparently absent; combined thickness of 2 corallite walls 0.3 to 0.5 mm.

Longitudinal Section Description. Tabulae generally complete, irregularly spaced, much thinner than corallite walls, about 0.06 mm thick, 0.5 to 1.5 mm apart, generally flat and horizontal, some slightly sagging or domed, some at angle across corallite.

Documentation. UCMP holotype 37266, UCMP paratypes 37267–37269, LACMIP paratypes 6426–6429. Six thin sections and 16 polished sections from five coralla and three etched coralla from UCMP locality D-852 (holotype 37266, paratypes 37267–37269) and LACMIP locality 1125 (paratypes 6426–6429) were studied.

Discussion. No species of *Michelinia* or its closely related and perhaps synonymous genus *Pleurodictyum* Goldfuss, 1829, has been described previously from the Permian of North America (Sando, 1974, 1980a; Wilson, 1974), although Rowett (1969:15) reported *Michelinia* sp. in the Permian of Alaska, but did not describe it in that paper as he stated he had. Of the 11 species described from the Pennsylvanian of North America (Sando, 1974, 1980a), only four have corallite diameters comparable to those of *M. nelsoni*. These are *M. exilimura* Mather, 1915, from the Morrow Formation near Choteau, Oklahoma, *M. latebrosa* Moore and Jeffords, 1945, from the Otterville Limestone near Ardmore, Oklahoma, and elsewhere in Texas, northwestern Arkansas, and northeastern Oklahoma, *M. scopulosa* Moore and Jeffords, 1945, from the Lower Pennsylvanian of northeastern Oklahoma and northwestern Arkansas, and *M. spissata* Moore and Jeffords, 1945, from the Brentwood Limestone near Brentwood, Arkansas. *M. nelsoni* apparently lacks mural pores, whereas all of the above Pennsylvanian species have them variously developed from "not abundant" to "very numerous." In addition, the tabulae of *M. spissata* are mostly incomplete, whereas those of *M. nelsoni* are mostly complete.

Etymology. The species is for Dr. Samuel J. Nelson.

Genus *Neomultithecopora* Lin, 1963

***Neomultithecopora sandoi* n. sp.**

Figures 46a–f; 47a–f

Diagnosis. A species of *Neomultithecopora* characterized by the combination of relatively large corallites, clumped tabulae, and rare connecting tubules or mural pores. It has larger corallites than *N. syringoporoides*, *N. simplex*, *N. uralica*, and *N. repens*. It has smaller corallites than *N. berkhi*.

External Description. Corallum basally reptant, distally erect, phaceloid, irregularly hemispheroidal, maximum observed height 9 cm, width 7 cm (both incomplete); epitheca with fine and coarse rugae.

Internal Description. Corallites 1.8 to 2.6 mm diameter (generally about 2.0 mm), touching to as much as 2 corallite diameters distant; tabulae distally concave, convex, or elongate and cystlike, clumped in groups of as many as 6 in 2-mm vertical space, generally only 1 shape in a clump but all shapes may occur in a single corallite, present where sclerenchyme is thin or thick, absent in most parts, some crossing through openings connecting corallites; corallite wall distally thin, elsewhere thickened by sclerenchyme to as much as 1.1 mm thick, leaving tabularium as narrow as 0.1 mm; septal spines regularly superposed and juxtaposed grid-like in longitudinal and horizontal rows, conical, 0.1 to 0.2 mm long, about 0.1 mm diameter at base, dark brown color contrasting with lighter sclerenchyme, in transverse section present on corallite walls and in some on inner layers of sclerenchyme (as many as 30 on former, 15 on latter), in longitudinal section pointing inwards and gently upwards, about 0.1 mm apart, in tangential longitudinal section circular cross sections of spines in 2 or more vertical rows, about 4 or 5 in 1 mm vertically, spines in parallel rows regularly opposite one another; septal spines not present in every corallite or everywhere in corallites that have them; connecting processes scattered, rare, becoming mural pores between touching corallites or, more rarely, connecting tubules as long as 2.5 mm, with diameters to 1.1 mm between more distant corallites; sclerenchyme composed of minute, elongate fibers at right angles to corallite wall in both transverse and longitudinal sections, not bundled into trabeculae.

Documentation. UCMP holotype 37270, UCMP paratypes 37271–37279, LACMIP paratypes 6430–6438. Eighteen thin sections and 202 polished sections from 19 coralla from UCMP

Figure 44. *Bayhaium virginiae* n. sp. and *Engimalites roberti* n. sp. All parts x3.

Parts a through f. *B. virginiae* n. sp. **Parts a through d,** UCMP holotype 37261, transverse (a–c) and longitudinal (d) sections. **Parts e and f,** UCMP paratype 37262, transverse and longitudinal sections.

Parts g and h. *E. roberti* n. sp., UCMP holotype 37263, transverse sections.

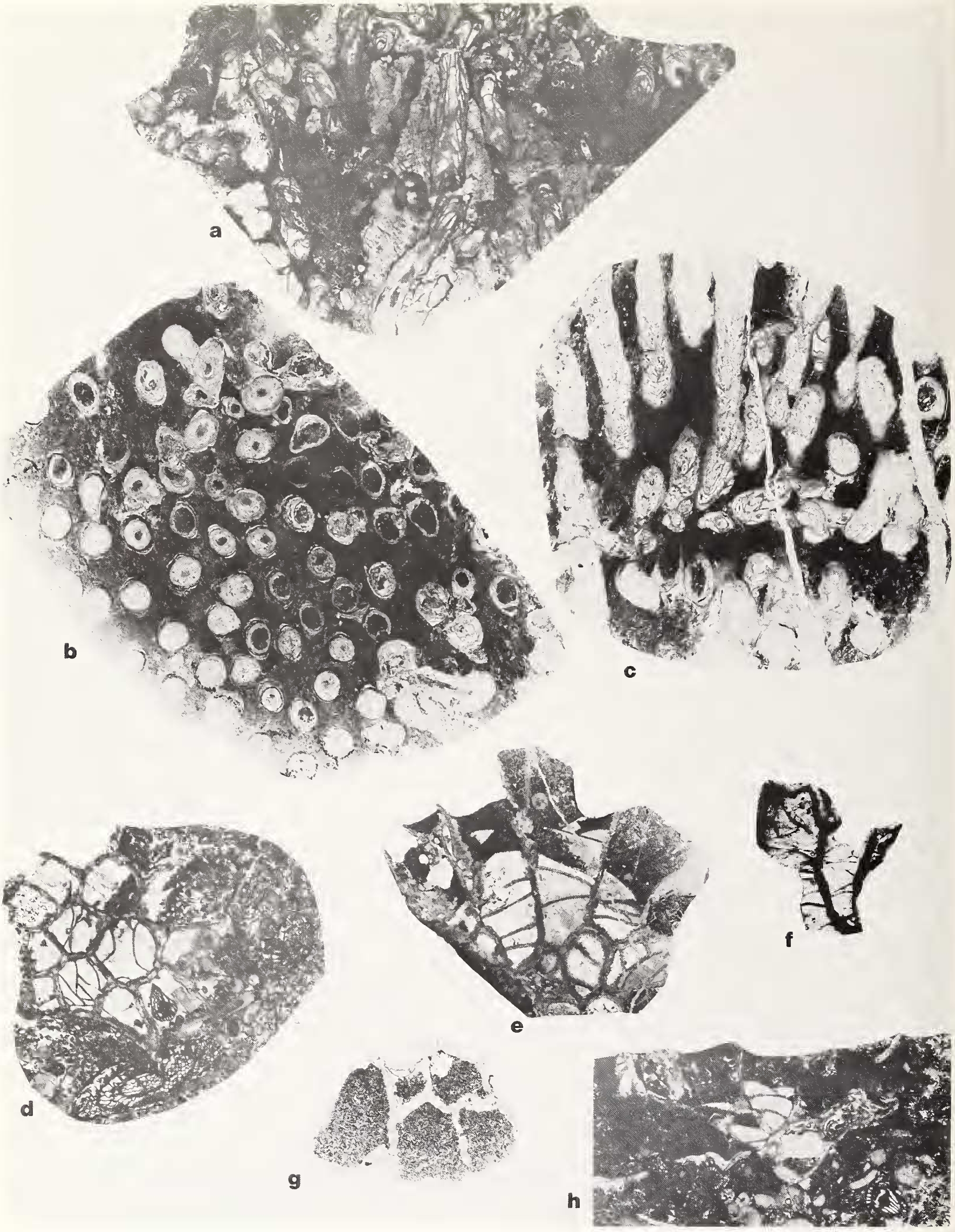

Figure 45. *Engimalites roberti* n. sp. and *Michelinia nelsoni* n. sp. All parts x3.

Parts a through c. *E. roberti* n. sp. **Part a,** UCMP holotype 37263, longitudinal section. **Parts b and c,** UCMP paratype 37264, transverse (b) and longitudinal (c) sections.

Parts d through h. *M. nelsoni* n. sp. **Parts d through g,** UCMP holotype 37266, transverse (d, g) and longitudinal (e, f) sections. **Part h,** LACMIP paratype 6426, longitudinal section.

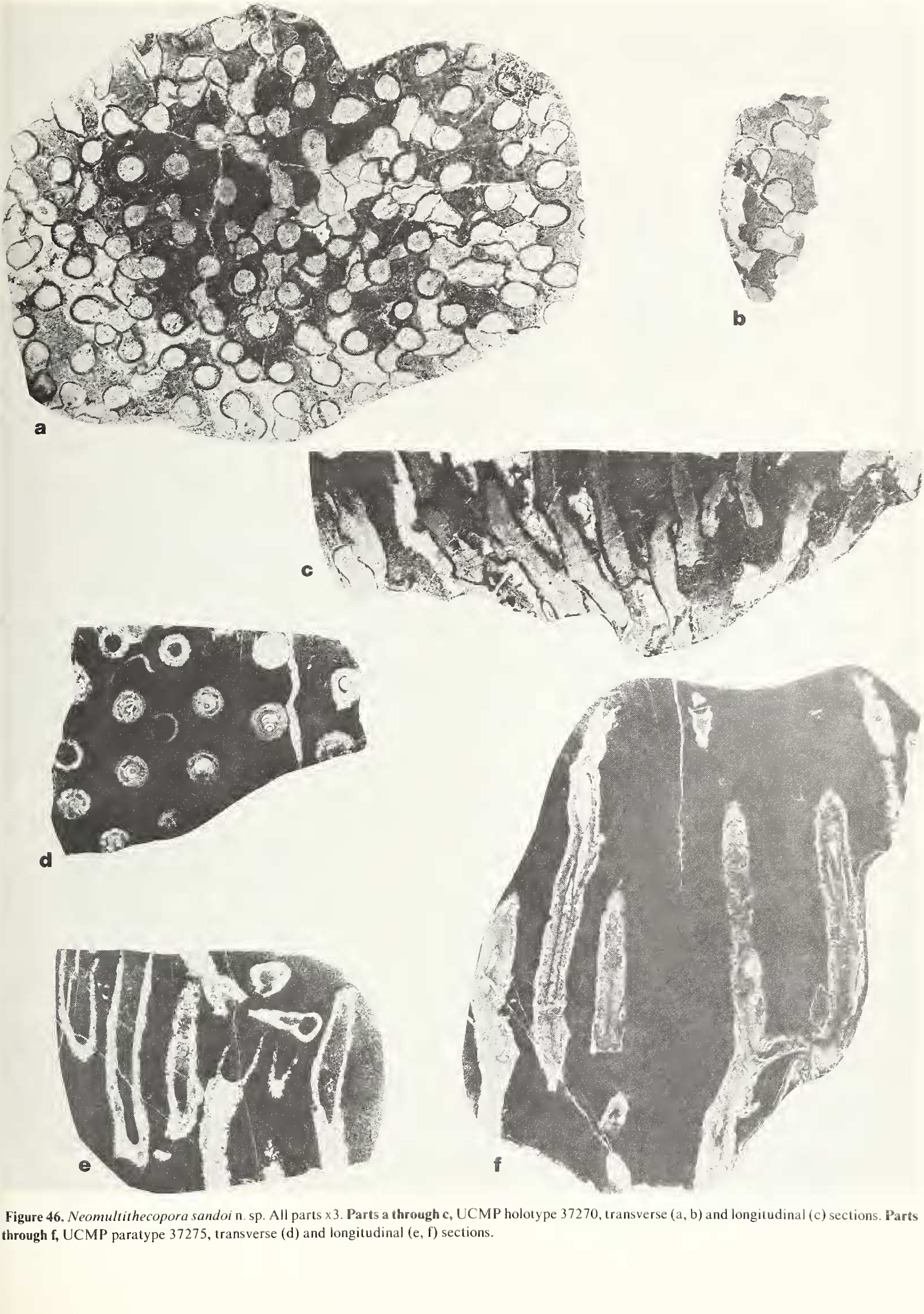

Figure 46. *Neomultithecopora sandoi* n. sp. All parts x3. **Parts a through c,** UCMP holotype 37270, transverse (a, b) and longitudinal (c) sections. **Parts d through f,** UCMP paratype 37275, transverse (d) and longitudinal (e, f) sections.

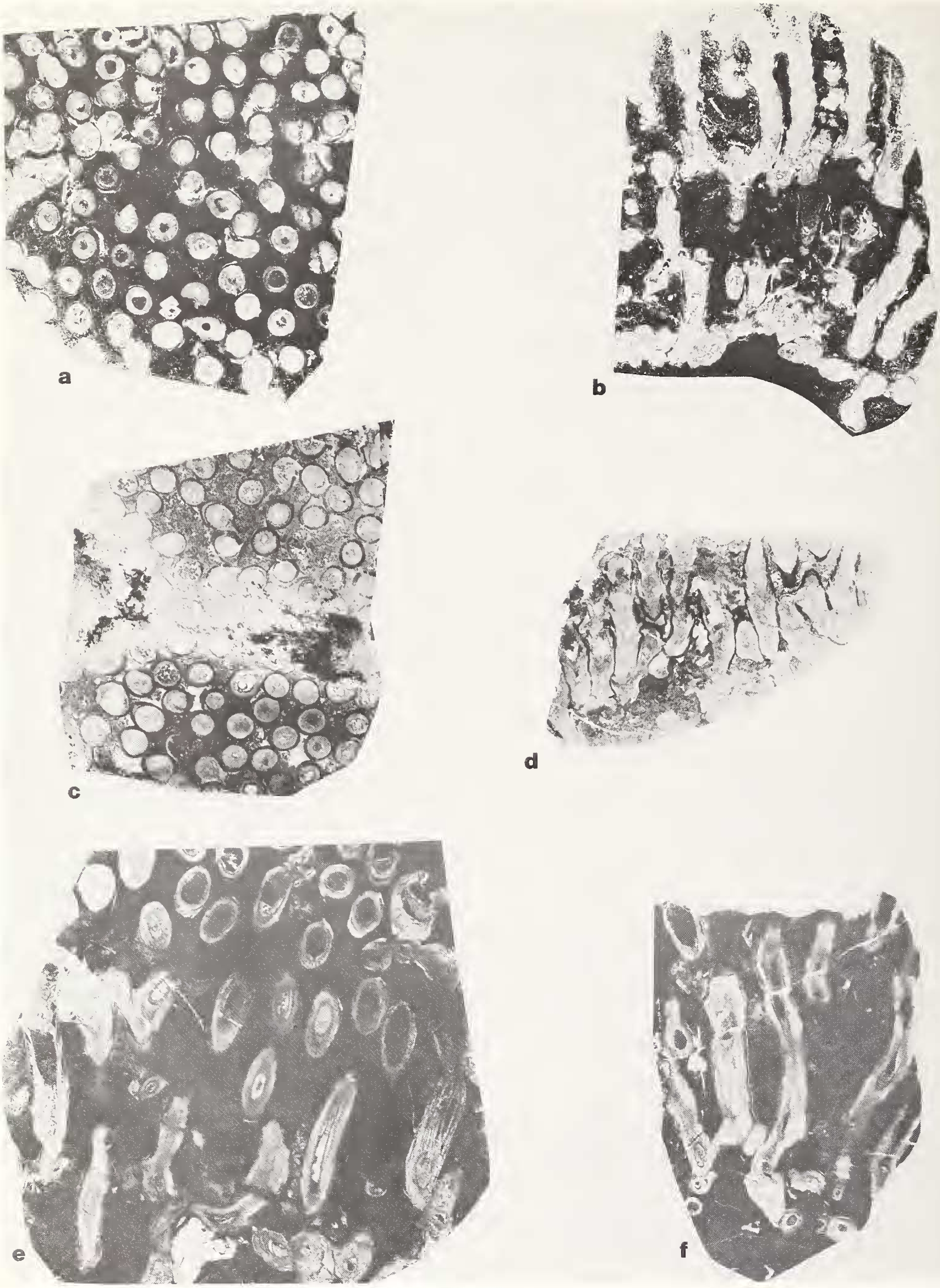

Figure 47. *Neomultithecopora sandoi* n. sp. All parts x3. **Parts a and b,** UCMP paratype 37277, transverse (a) and longitudinal (b) sections. **Parts c and d,** UCMP paratype 37278, transverse (c) and longitudinal (d) sections. **Parts e and f,** LACMIP paratype 6438, transverse and longitudinal sections (e) and longitudinal section (f).

localities D-801 (paratypes 37271–37273), D-803 (holotype 37270), D-822 (paratype 37274), D-831 (paratypes 37275–37276), D-832 (paratype 37277), and D-858 (paratypes 37278–37279) and LACMIP localities 1125 (paratypes 6430–6431), 1132 (paratypes 6432–6433), 1133 (paratypes 6434–6437), and 4457 (paratype 6438) were studied.

Discussion. This is the first report of *Neomultithecopora* in North America and the first record of it in the Permian. The type species, *N. syringoporoides* Lin, 1963, is from the Lower Carboniferous of south China. Other species occur in the Lower Carboniferous, and questionably Upper Carboniferous, of the Ural Mountains and Novaya Zemlya of Russia (Kachanov, 1967:24; Tchudinova, 1975a:17).

This genus is separated from *Multithecopora* Yoh, 1927, chiefly on the basis of the presence of very symmetrically arranged septal spines in the former and perhaps also by microstructural differences of the sclerenchyme. *Multithecopora* seems to have sclerenchyme arranged in concentric layers, whereas *Neomultithecopora* has sclerenchyme composed of radially arranged fibers. The only other tabulate coral with highly thickened walls from the McCloud Limestone, *Bayhaium* Langenheim and McCutcheon, 1959, also has sclerenchyme composed of calcite fibers (Lafuste, 1963), but they differ from those of *Neomultithecopora* in being bundled into trabeculae.

Some of the coralla of *N. sandoi* have wholly or partially silicified walls. The silicified parts are a pale blue, whereas the septal spines are brown. The septal spines are most obvious when observed in reflected light but not always apparent when examined in thin section by transmitted light.

N. sandoi has greater corallite diameters than *N. syringoporoides* from the Lower Carboniferous of south China, *N. simplex* Kachanov, 1967, from the Lower Carboniferous of the Ural Mountains, and *N. repens* (Stuckenberg, 1895) from the Upper Carboniferous of the Ural Mountains. The latter species is here placed in the genus based on the report of Tchudinova (1975a:17) that it has septal spines.

N. berkhi (Gorskiy, 1951), from the Lower Carboniferous of Novaya Zemlya and the Ural Mountains (Kachanov, 1967:29) has greater corallite diameters than *N. sandoi*.

N. uralica Kachanov, 1967, from the Lower Carboniferous of the Ural Mountains and Novaya Zemlya, has abundant connecting tubules, whereas *N. sandoi* has very few.

Etymology. The species is named for Dr. William J. Sando.

Genus *Syringopora* Goldfuss, 1826

Syringopora mccutcheonae Wilson and Langenheim, 1962

Figures 48a–b

Syringopora mccutcheonae Wilson and Langenheim, 1962:515, pl. 89, figs. 11–13.

S. mccutcheonae Wilson and Langenheim. Langenheim and Langenheim, 1965:235.

Documentation. UCMP hypotype 37280. Five thin sections and 35 polished sections from one corallum from UCMP locality D-842 were studied.

Discussion. This species is geographically widespread in Lower Permian strata of eastern Nevada (Wilson and Langenheim, 1962; Langenheim and Langenheim, 1965). The McCloud Limestone corallum agrees very closely with the Nevada specimens in corallite diameter, absence of septa and septal spines, and general occurrences of connecting processes at the same levels in the coralla. Apparent differential silicification in some corallites gives the impression that sclerenchyme-embedded septa are present.

Syringopora multattenuata McChesney, 1860

Figures 48c–f

Syringopora multattenuata McChesney, 1860:75.

Syringopora multattenuata McChesney, 1867:2, pl. 2, fig. 4.

Syringopora multattenuata McChesney. McCutcheon, 1961:1014, pl. 121, figs. 1–8.

Documentation. UCMP hypotypes 37281–37282. Six thin sections and 30 polished sections from one corallum from UCMP locality D-825 (hypotype 37281) and two thin sections and 26 polished sections from one corallum from UCMP locality D-853 (hypotype 37282) were studied.

Discussion. This species was thoroughly reviewed by McCutcheon (1961), who summarized the geographic occurrence as "widespread in Pennsylvanian rocks of the United States . . . in the Permian of Spitzbergen . . . in the Wolfcampian of the Arrow Canyon Range, Clark County, Nevada." The McCloud Limestone specimens agree closely with the neotype and hypotypes of McCutcheon (1961), except that the corallite diameters of the McCloud specimens, while generally about 2 mm, do range as high as 2.5 and 2.8 mm in a few corallites, which is somewhat greater than the 2.2-mm maximum cited by McCutcheon (1961:1014).

Sando (1965:32) commented on the differences and similarities of *S. multattenuata* and *S. occidentalis* Meek, 1877, from the Pennsylvanian Weber Sandstone or Permian Park City Formation of Utah, and concluded that ". . . in *Syringopora multattenuata* the axial tube is more clearly defined and the incomplete tabulae are more numerous, more variable in size, and generally more inflated than in *S. occidentalis*."

LOCALITIES

The following localities are entered in the UCMP and LACMIP locality registers. They all are located in the McCloud Limestone. Abbreviations also are used for United States Geological Survey (USGS), township (T), range (R), north (N), south (S), east (E), and west (W). References to fusulinid zones are those of Skinner and Wilde (1965), with age determinations amended by Wilde (1971:364).

UCMP Localities

A-7096. Bayha section (lower part is the Tunnel Inn section of Skinner and Wilde, 1965). It is on the ridge most likely collected by the California Geological Survey in 1862. The traverse begins at the lowest exposure near the base of the W face of the ridge with summit marked "1693" in the NE ¼ of section 15, T 33 N,

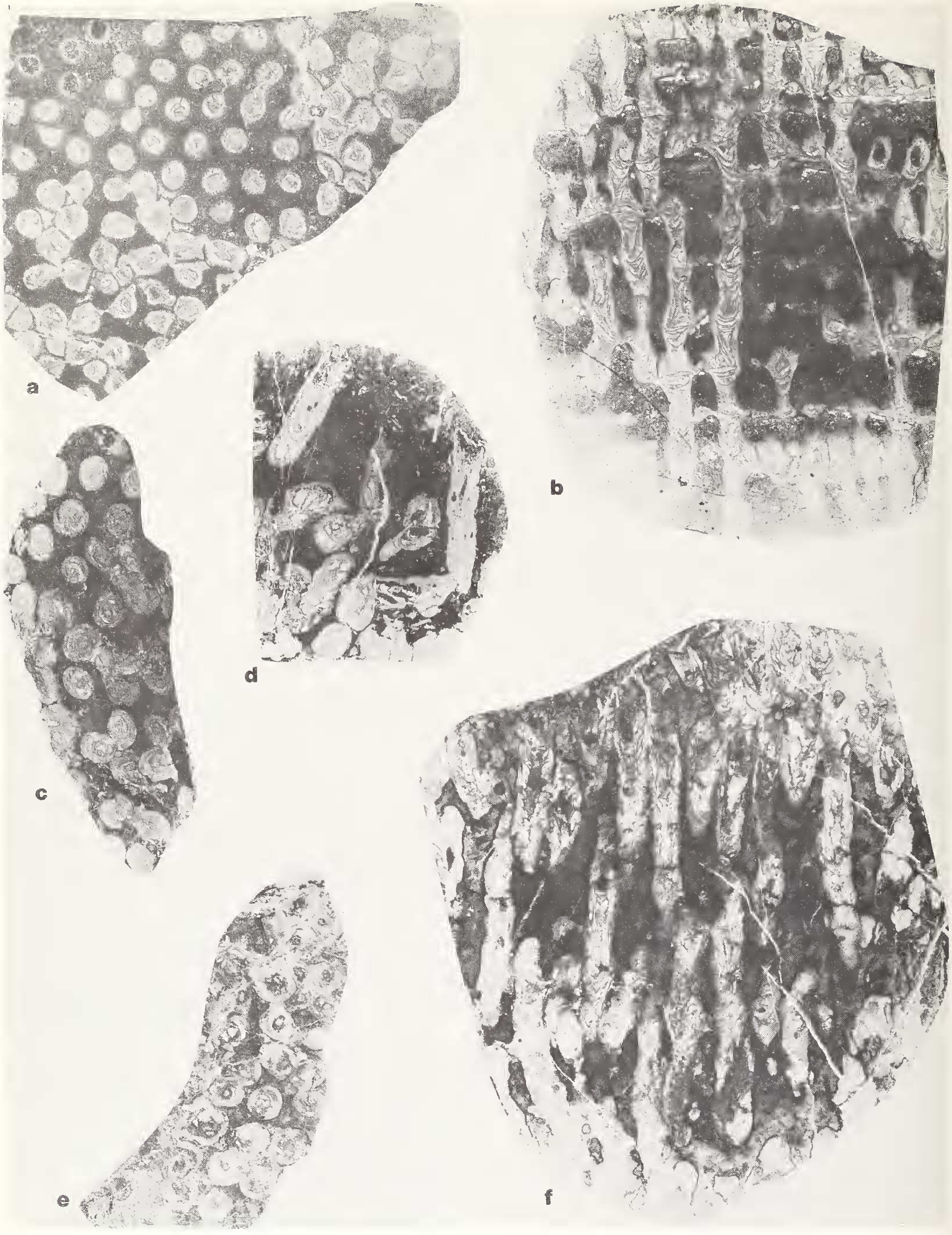

Figure 48. *Syringopora mccutcheonae* Wilson and Langenheim, 1962, and *S. multattenuata* McChesney, 1859. All parts x3.

Parts a and b. *S. mccutcheonae*, UCMP hypotype 37280, transverse (a) and longitudinal (b) sections.

Parts c through f. *S. multattenuata*. **Parts c and d,** UCMP hypotype 37281, transverse (c) and longitudinal (d) sections. **Parts e and f,** UCMP hypotype 37282, transverse (e) and longitudinal (f) sections.

R 4 W, as shown on the USGS 7.5-minute topographic quadrangle of Project City, California (1957), continues due E over the summit of the ridge, down the E dip slope into cover, offsets slightly S and continues up a smaller limestone hill, down again into cover and ends at the second of two 2-foot (0.6-meter) thick limestone units, which crop out of deep soil in the saddle shown in the NW ¼ of section 14, T 33 N, R 4 W, of the same map. Thicknesses recorded for this section include sills of quartz diorite found in it. A-7096 is 500 feet (152.4 meters) above the base of the section and has abundant cerioid corals, small solitary corals, and rare, large pelmatozoan columnals. Fusulinid zone F.

A-7101. W bank of the McCloud River at river level and N of the McCloud River bridge as shown in the NE ¼ of section 31, T 35 N, R 3 W, of USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957). Silty limestone with some coquinoid beds of echinoid plates and spines, syringoporid corals, fusulinids. Same as LACMIP locality 1123. Fusulinid zone F.

B-4837. This locality is in the NE ¼ of the SW ¼ of section 35, T 33 N, R 4 W, as shown on the USGS 7.5-minute topographic quandrangle of Project City, California (1957). It is a nearly covered, small limestone outcrop N of a small tributary that flows into the East Fork of Stillwater Creek. A single corallum of a fasciculate coral was collected here by Mr. Chang Ki Hong of Korea in 1962 and brought to me at UCMP for identification. The matrix on the coral has a speeimen of the fusulinid *Pseudoschwagerina robusta* (Meek, 1864). I examined the locality but found no other fossils. Fusulinid zone E.

D-181. Bayha section, 415 feet (126.4 meters) above the base. Cerioid tabulate corals, cerioid rugose corals. Fusulinid zone F.

D-800. Lowest black limestone unit on spur SE of the forest service building ¼ mile S of the McCloud River bridge on Gilman Road as shown in the SE ¼ of section 32, T 35 N, R 3 W, of the USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957). Large solitary rugose corals, *Omphalotrochus*, *Hustedia* Hall and Clarke, 1893, fusulinids, fenestellid bryozoans. Fusulinid zone A.

D-801. Estimated 300 feet (91.4 meters) stratigraphically above D-800. Syringoporid corals to 2 feet (0.6 meters) in diameter, large solitary rugose corals, *Omphalotrochus*. Fusulind zone B.

D-803. Float collection made an estimated 700 feet (213.4 meters) stratigraphically above D-801. Large solitary rugose corals, cerioid rugose corals, syringoporid corals. Fusulinid zone B or C.

D-804. An estimated 150 feet (45.7 meters) stratigraphically above D-803 on spine of spur. Fasciculate rugose corals. Fusulinid zone C.

D-805. Due E of D-804 on spine of spur an estimated 300 feet (91.4 meters) stratigraphically below summit of main N-S ridge. Fasciculate rugose corals. Fusulinid zone B.

D-819. McCloud Bridge East section. Probably same as Skinner and Wilde's (1965) McCloud Guard Station section. This traverse begins at the lowest exposures of the formation on the first spur S of the E end of the McCloud River bridge as shown in the NE ¼ of the SE ¼ of section 31, T 35 N, R 3 W, of USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957), and continues E over the top of the high ridge, stopping at cover in the saddle at the east end of the dip slope as shown in the NE ¼ of the SW ¼ of section 32, T 35 N, R 3 W, same map. D-819 is 1140 feet (347.5 meters) stratigraphically above the base of the section. Many silicified fossils, large solitary corals, *Conocardium langenheimi*, *Omphalotrochus*, fusulinids. Same as LACMIP locality 4458. Fusulinid zone A.

D-821. Wide bench below sheer cliff 410 feet (125 meters) stratigraphically above D-819. Fusulinids, solitary rugose corals, syringoporid corals, brachiopods, bryozoans, bivalves. Same as LACMIP locality 1132. Fusulinid zone B.

D-822. Bench 34 feet (11 meters) stratigraphically above D-831. Large solitary rugose corals, syringoporid corals. Fusulinid zone B.

D-825. Beds 310 feet (94.5 meters) stratigraphically above D-822. Syringoporid corals. Fusulinid zone C.

D-826. Bench 130 feet (40 meters) stratigraphically above D-825. Large solitary rugose corals. Fusulinid zone C.

D-827. Beds 20 feet (6.1 meters) stratigraphically above D-826. Fusulinids and cerioid rugose corals. Fusulinid zone C.

D-828. Topographic summit of main ridge of section, 670 feet (204 meters) above D-827. Fusulinids, fasciculate rugose corals. Fusulinid zone C.

D-831. Approximately 200 yards (183 meters) S of D-819 and about 15 feet (4.6 meters) stratigraphically higher. Fusulinids, abundant large solitary rugose corals, abundant syringoporid corals, *Conocardium langenheimi*. Same as LACMIP locality 1133. Fusulinid zone A.

D-832. Approximately 100 yards (91.4 meters) S of D-831 and an estimated 10 feet (3 meters) stratigraphically higher. Syringoporid corals and large solitary rugose corals. Fusulinid zone A.

D-834. Potter Ridge section. The traverse begins at the lowest exposure of the formation on the W end of the ridge between Potter and Marble Creeks as shown in the SE ¼ of section 23, T 33 N, R 4 W, USGS 15-minute topographic quadrangle of Lamoine, California (1957), and continues up the ridge crest to the base of the intrusive overlying the last limestone unit in the saddle E of the nob on the ridge as shown in the NW ¼ of the SW ¼ of section 24, T 33 N, R 4 W, same map. Thicknesses recorded for this section include sills of quartz diorite. D-834 is 130 feet (39.6 meters) above the base of the section. Fasciculate rugose corals. Fusulinid zone E.

D-836. Beds 80 feet (24.4 meters) stratigraphically above D-834. Fasciculate and large solitary rugose corals. Same as LACMIP locality 1114. Fusulinid zone E.

D-837. Beds 25 feet (7.6 meters) stratigraphically above D-836. Fusulinids, cerioid and cerioid-astreoid rugose corals. Fusulinid zone E.

D-838. Beds 65 feet (19.8 meters) stratigraphically above D-837. Fasciculate rugose corals, cerioid syringoporid corals, *Omphalotrochus*. Fusulinid zone E.

D-839. Beds 10 to 35 feet (3 to 10.8 meters) stratigraphically above D-838. Cerioid syringoporid corals. Fusulinid zone F.

D-840. Beds 230 to 340 feet (70 to 103.6 meters) stratigraphically above D-839. Fasciculate rugose corals. Fusulinid zone F.

D-841. Beds 285 feet (86.8 meters) stratigraphically above D-840. Fusulinids, solitary and cerioid rugose corals. Fusulinid zone F.

D-842. Beds 320 feet (97.5 meters) stratigraphically above D-841. Large solitary rugose corals with and without axial structures, cerioid rugose corals, syringoporid corals, large bellerophontid gastropods. Same as LACMIP locality 1116. Fusulinid zone F.

D-843. Beds 20 feet (6.1 meters) stratigraphically above D-842. Fusulinids, large solitary and cerioid rugose corals, gastropods. Fusulinid zone F.

D-845. Beds 105 feet (31.9 meters) stratigraphically above D-843. Large cerioid rugose corals. Fusulinid zone F.

D-852. Summit of Hirz Mountain, dip slope E of the foot of the lookout tower as shown in the SE ¼ of section 7, T 35 N, R 3 W, of the USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957). Very rich fauna including fusulinids, syringoporid corals, solitary, fasciculate, cerioid-astreoid, and cerioid rugose corals, brachiopods, and gastropods. Same as LACMIP locality 1125. Probably fusulinid zone D.

D-853. Hirz Mountain section. The traverse begins at the lowest exposure of the formation of the NW face of the N end of the ridge that forms the summit of Hirz Mountain, as shown in the SE ¼ of section 7, T 35 N, R 3 W, of the USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957) and continues E over the N end of the summit ridge and down the E face into cover as shown in the SE ½ of section 7 and the SW ¼ of section 8, T 35 N, R 3 W, of the same map. D-853 is 125 feet (37.1 meters) stratigraphically above the base. Syringoporid corals. Fusulinid zone D.

D-855. Beds 420 feet (128 meters) stratigraphically above D-853. Fusulinids, cerioid and fasciculate rugose corals, brachiopods. Fusulinid zone D.

D-857. Beds 240 feet (73 meters) stratigraphically above D-855. Fusulinids, cerioid and fasciculate rugose corals. Fusulinid zone D.

D-858. Beds 10 feet (3 meters) stratigraphically above D-857. Cerioid and fasciculate rugose corals, syringoporid corals. Fusulinid zone D.

D-861. Basal 50 feet (15.2 meters) of the Bayha section. Abundant fusulinids including *Pseudoschwagerina robusta* (Meek, 1864), solitary and fasciculate rugose corals, brachiopods, *Omphalotrochus whitneyi* (Meek). Some of Meek's (1864) specimens were collected from this stratigraphic interval, but not necessarily from this locality. See A-7096 for map description. Same as LACMIP locality 1119. Fusulinid zone E.

D-862. Beds 245 feet (74.7 meters) stratigraphically above D-861. Fusulinids, fasciculate rugose corals. Fusulinid zone F.

LACMIP Localities

1114. See UCMP locality D-836.

1116. See UCMP locality D-842.

1119. See UCMP locality D-861.

1120. Beds in the Bayha section, 380 feet (115.8 meters) stratigraphically above base. Fasciculate rugose corals. Fusulinid zone F.

1121. Beds 45 feet (13.7 meters) stratigraphically above 1120. Large fasciculate corals. Fusulinid zone F.

1122. Beds 45 feet (13.7 meters) stratigraphically above 1121. Cerioid and fasciculate rugose corals. Fusulinid zone F.

1123. See UCMP locality A-7096. Fusulinid zone F.

1124. Beds 10 feet (3.0 meters) stratigraphically above 1123. Fasciculate and cerioid rugose corals. Fusulinid zone F.

1125. See UCMP locality D-852.

1132. See UCMP locality D-821.

1133. See UCMP locality D-831.

1285. McCloud Point section. The traverse begins on the E bank of the McCloud River Arm of Shasta Lake at the first limestone exposure on Point McCloud as shown in the NW ¼ of the SW ¼ of section 5, T 35 N, R 3 W, of the USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957), and ends at the highest exposure of the formation W of and about the same elevation as Gilman Road. This is the upper part of the McCloud Point section of Skinner and Wilde (1965). In this section, only this locality contained corals. It is 600 feet (182.5 meters) stratigraphically above the base of the section. Fasciculate and cerioid rugose corals. Impossible to collect the cerioid corals. Fusulinid zone G.

4457. Basal 100 feet (30.5 meters) of the McCloud Bridge West section (see 5312 for description), along strike on the SW side of the hill from the line of section and topographically above Gilman Road. Fasciculate rugose corals. Fusulinid zone A.

4458. See UCMP locality D-819.

5312. McCloud Bridge West section. The traverse begins at the lowest exposure of the formation on the SW slope of the hill at the W end of the McCloud River Bridge and NW of Gilman Road and runs NE to the crest of the hill and down the NE side into cover as shown on the NE ¼ of section 31, T 35 N, R 3 W, of the USGS 15-minute topographic quadrangle of Lamoine, California (1957), and the SE ¼ of section 30, T 35 N, R 3 W, of the USGS 15-minute topographic quadrangle of Bollibokka Mountain, California (1957). Locality 5312 is 260 feet (79.2 meters) stratigraphically above the base of the section. Solitary rugose corals, brachiopods, *Omphalotrochus* (?). Fusulinid zone A.

5316. Beds 220 feet (67 meters) stratigraphically above 5312. Enormous fasciculate rugose coralla (largest 5 feet in diameter), *Omphalotrochus*. Fusulinid zone A.

5318. Beds 75 feet (22.9 meters) stratigraphically above 5316, at the summit of the hill. Large solitary rugose corals, brachiopods. Fusulinid zone A.

5319. Beds 1 to 25 feet (0.3 to 7.6 meters) stratigraphically above 5318, at the top of the dip slope. Large solitary rugose corals. Fusulinid zone A.

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